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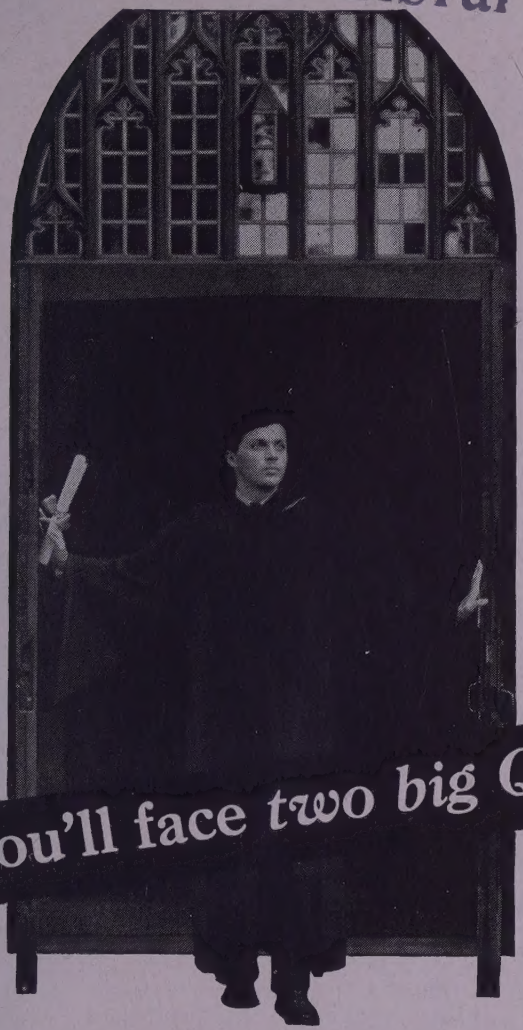

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This advertisement appears in College Engineering Publications during October, November and December, 1947

41389

New Developments

By John Dick, E.E. '49

Weld Engineering Cuts 33 Operations to 5

A simple design and process change can sometimes produce important savings in production costs, while increasing output and improving quality.

This is demonstrated in the case of a reinforced bus pillar, fabricated from 13 separate stampings by Hawthorne Metal Products company, Detroit, and designed originally for single spot welding. This in itself resulted in a rather low fabricating cost. When the job was released for production, however, the supplier of the welding equipment—Progressive Welder company of Detroit—recommended the forming of a series of projections in five of the stampings at the time that these were produced.

The new stampings were then attached to the pillars by projection welding, using a press type welder. As a result, only one operation was required to join each of these five stampings to the pillar proper instead of 33 individual spot welds.

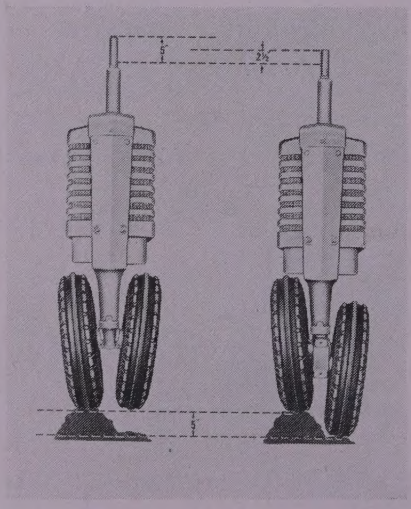
Moreover, by using simple locating dies in the press welder it was possible to get accurate locating and alignment without clamping of the parts prior to welding. The net result of the changes was to double the productivity of the welding equipment, 100 completed assemblies being produced per hour in comparison to 50 per hour by straight spot welding, and at the same time cut the fabricating cost in half.

"Knee-Action" Front Wheels

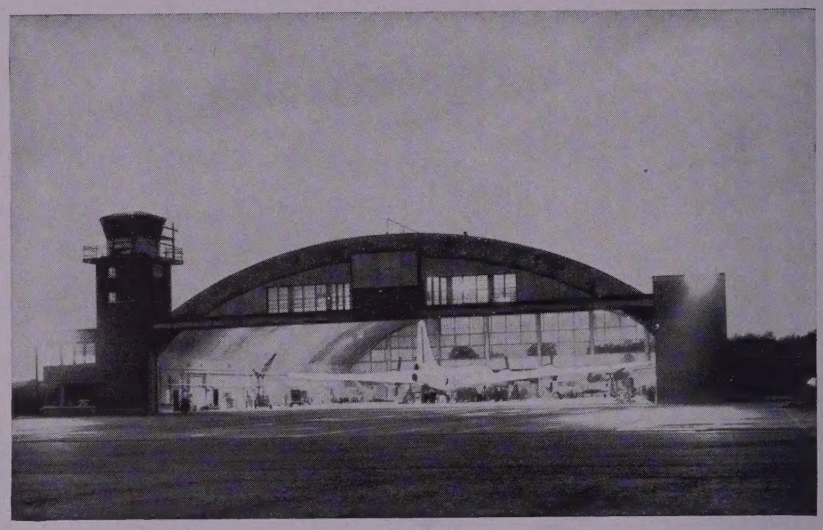
The latest innovation in tractor design was announced recently by the John Deere Tractor company, of Moline, Illinois. The idea consists of adapting the knee-action wheel idea to farm tractors. Manufactured under the trade name of "Roll-O-Matic," the knee-action principle applied only to the front wheels results in increased smoothness and safety of operation along with longer tire life.

As shown in the accompanying illustration, the fundamental principle of operation of the "Roll-O-Matic" knee-action front wheels is readily seen. Mechanically, a gearing system is included so that the slightest up or down movement of one wheel is instantly transferred to the other which automatically equalizes the load. At the same time the up and down movement of the front end of the tractor as it goes over bumps and clods is reduced to 50 per cent that of the conventional wheel arrangement.

By minimizing this up and down movement of the front end, and by automatically equalizing the load on each tire, the "Roll-O-Matic" front wheels promise a safer, more comfortable ride and greatly increased front tire life.



Diagramatic sketch showing how "knee-action" limits the front end motion by 50 per cent.



The latest addition to the "flying laboratories" is the B-29 whose space permits engineers and designers to study the gas turbine in actual use

Flying Test Stands

Working on a flight testing project sponsored jointly by the Army Air Forces and the General Electric company, engineers and designers have been able to gain invaluable assistance in the design of aircraft gas turbines through utilizing army bombers which have been converted into flying laboratories.

Inaugurated in 1942 when the Flight Test Division obtained a B-23 for flight investigations of the turbo-supercharger, the division has since used many different types of army aircraft to serve in the role of "papa" to experimental equipment. The most recent and largest of the planes to be used for this purpose is the B-29, shown in the accompanying illustration as it is being equipped for service.

Since the jet power plants are installed as auxiliary equipment rather than substitute engine, the method has proved to be a safe and expedient way of conducting the tests under altitude conditions. Although used at the present time mostly for tests on the powerful TG-180 gas turbine, the flying laboratories have proved quite successful in the testing of new gas turbine units prior to actual installation aboard aircraft.

In addition to these advantages the method has also enabled important components to be tested with older engines before the completed unit is ready.

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OUR COVER

Typical of the problems faced by many veteran students is this picture of "Study Hour." Dont laugh, it could happen to you.

FRONTISPIECE

Shown assembling a new television antenna, these two workmen are perched high on the Empire State building. (Courtesy of General Electric company).

Look Before You Leap

By Carl Sonnenschein, M.E. '48

Some people are adaptable to any situation or job, but most are not. All too often a man, or woman, finds out, too late, that he has accepted a position which does not appeal to him and for which he is unable to show the proper interest. Are you going to be one of this misplaced and misled group?

It is a generally accepted fact that one reason people go to school is to increase their ultimate earning power. As a group, engineers are not the highest paid of the professional men and women, although there are exceptions. However, in order for a person to be able to accept greater responsibilities and hence a larger remuneration, he must have a real and vital interest in the work which he is doing.

There are several basic considerations which enter into the acceptance or rejection of a job offer, and for the most part they are predicated upon personal desires, likes, and dislikes.

Let us now consider the average student as he approaches the ultimate goal, graduation.

Needed—A Job

Having completed almost four years of constant and intensive study he finds that very shortly his period of incubation, as an engineer, will end. It is usually at this time that the prospect of having to choose a job is first brought forcibly to his attention. There are a few persons who already have a course of action laid out for themselves, but they are the lucky few.

Now that the realization of the necessity of getting a job has become manifest, the student arranges, through the college office, to have several interviews.

The number of interviews the student has will vary according to the indivdual. Some persons may need only one or two in order to make their decision, while others will require a half dozen or more.

Advice from the Dean's office indicates, that the greatest difficulty that the interviewers find with the students is that they do not know what they want, nor do they come to the interviews equipped to ask intelligent questions.

All too often, due to this unpreparedness and indecision, a man may either pass up a good offer, or he may accept a job for which he is mentally unqualified. This can only lead to a condition of unhappiness and discontent with his work.

The purpose of this article is not to try to tell anybody which job they should or should not accept, but rather it is an attempt to point out a few of the factors which should be considered by all persons seeking employment. Neither is the article intended only for those seniors who expect to graduate in the near future but is applicable to freshmen and sophomores as well. This will become more evident as we proceed.

This article is the first of a series designed to impress upon the student the realization that the ultimate goal of all education lies in the proper selection of a job in which he can best utilize his talents and training. Although space does not permit a complete discussion on the subject of selecting a job, the article at least suggests many lines of investigation that may be followed by the student who is truly interested in fitting himself into a more than just adequate job. In attempting to help open up one line of investigation, the subsequent articles in this series will deal with specific descriptions of several small industrial organizations located in the State of Illinois. They have been chosen because they are also representative of a group of employers with whom the engineering student has had little direct contact.

Most of the engineering curricula in the junior and senior years provide opportunity for the student to take options which give him a chance to develop any special interests he may have.

This line of attack is of utmost importance but its significance is completely lost to the student who has not put forth any effort toward developing specialized interests.

We must accept the fact that engineering today is such a broad and comprehensive field that no one man can possibly be accomplished in all of its ramifications. As a result of this condition, engineers have become a group of specialists. When a man decides to become a specialist, he automatically narrows his future into a well defined path; and, once having made the choice, it will be very sad and disillusioning for the person who then finds that he does not like and enjoy the work he is doing.

For the most part, freshmen are excluded from extra-curricular activities until they have qualified themselves scholastically. For those who are qualified the numerous engineering societies and other school activities are a deep well for the accumulation of an insight into the various phases of engineering. The student should take full advantage of these opportunities that are offered to him to learn about his and other professions.

Summer Jobs Valuable

The accumulation of practical experience of various types, through the medium of summer jobs, is another fine way of acquiring this diverse knowledge.

Unfortunately for the student, most of the trade publications are far too technical for all but the seniors and some juniors to be able to read and understand. However, mere perusal of these publications is, or should be, of interest to all engineering students.

All of these things which have been mentioned will help to prepare a person to make up his mind when the time comes.

In the final analysis, the true proof of the pudding is in the eating, so it is impossible to be absolutely sure that your choice is the right one until after you have worked at the job for a while. Nevertheless, prior to employment, an honest consideration of all factors should greatly increase the chances of making the correct choice.

Now let us consider the senior who has accomplished his formal educational program and is about to set forth on the real business of living. Let us assume that this particular individual has thought over the prospects and has decided upon what type of work he wants to do. The only question he has yet to answer is, "Whom shall I work for?"

As we have already mentioned, the college office arranges for interviews between representatives of industry and the students. This is one of the finest services, of many, that the office does provide.

Analyze the Problem

When our student approaches his interview, there are a number of important questions to which he should desire the answers.

The locale of the employment is always an important consideration, especially in these days of housing shortages. Should it not be possible to obtain adequate housing it would be absolutely foolish for a person to try to accept a

(Continued on Page 22)

The Gyro Compass

By Herbert Mazer

Even though the principle of operation of the Sperry gyro-compass may be well known to the reader, you will find in this article a clear description of not only how it functions but also some of the problems encountered in its design.

As late as the middle of the 19th century, there were people that still clung to the belief that the universe rotated around a stationary earth. Scientists had attempted to disprove this fallacy as early as the 17th century, but could not decisively do so. In 1851, Jean Bernard Leon Foucault, a prominent French scientist of the period, threw some light on the situation by showing that the earth was actually rotating on its axis.

Incorporating theories developed by Galeleo, Newton, and Kepler, he mounted a wheel in a frame on very delicate bearings so that it could maintain its spinning axis in a fixed direction. By conducting a series of experiments with this apparatus, he proved that the earth turned relative to the stationary direction of the spinning axis of the wheel. Foucault called his delicate apparatus a gyroscope from the Greek word "gyros" (revolution), and "skopien," (to view), and he predicted that some day it would be used to navigate ships.

At the turn of the 20th century, Dr. Elmer A. Sperry, founder of the Sperry Gyroscope company, became intrigued with the many possibilities of mechanical applications of the gyroscope and dedicated himself to the development of gyro-statics.

Before going into the problem confronting Dr. Sperry in the development of the gyro-compass, it would be best to define the gyroscope and briefly state its properties.

A gyroscope consists of a solid wheel with its mass concentrated about the rim. It is so suspended that it may rotate about its spinning axis and turn about its vertical and horizontal axes. These axes are mutually perpendicular and coincide with the center of mass at the geometric center of the wheel. Its physical properties are: (1) the ability to hold its position in space unless acted upon by an external torque, and (2) if such a torque were applied, action would take place about an axis 90 degrees from the applied torque. In other words, if a torque were placed on the vertical axis, the gyroscope would turn about its horizontal axis. This peculiar property is known as "precession."

Dr. Sperry had a series of obstacles to hurdle before he could build his first gyro-compass. The first, the problem of a continuously spinning rotor, was easily overcome by evacuating the center of the gyro-wheel and installing a set of induction windings; thus making the gyro-wheel the rotor of an induction motor. Rotors in the most commonly used Sperry compasses weigh 55 lbs. and develop a speed of approximately 6,000 r.p.m. They are driven by induction windings supplied with 50 volt, 3 phase, 210 cycle alternating current.

The problem of making a gyroscope north-seeking and north-remaining was more complex. Dr. Sperry knew that if the plane of rotation of a gyroscope were parallel to the earth's plane of rotatin, their spinning axes would point to the true geographic north and south. The rotation of the earth would cause no deviation from the true north and, by definition, the gyroscope would become a compass. For all practical purposes, however, it would be impossible to set the plane of rotation of a gyroscope parallel to the earth's plane of rotation unless a mechanical setup was used. Dr. Sperry conceived an ingenious method. Utilizing the gyroscopic property of precession and the apparent tilting of the gyro-rotor because of the rotation of the earth, he placed a tank of mercury on each side of the rotor and connected them with a unrestricted pipe; thus allowing mercury to flow freely from one tank to the other. He attached these to the bottom of the rotor case by means of a connection arm and an eccentric pin, (called "eccentric" because it is attached approximately 1° from the perpendicular).

Let us see what effect the addition of mercury ballistic tanks had on the gyro-scope. Assume the rotor to be level and pointing east and west. As the earth rotates from west to east, the east end of the gyro-scope will appear to tilt up. This apparent tilting will cause mercury to flow from the east to the west ballistic tank and, in effect, place a torque on the horizontal axis. Following the rule of precession previously stated, the rotor will commence to turn about its vertical axis.

Due to the unrestricted flow of mercury, the rate of precession is directly proportional to the angle of tilt and, since the earth rotates continually, the amount of tilt will gradually increase until the spinning axis of the rotor moves into the plane of a meridian. At this point, the angle of tilt, the amount

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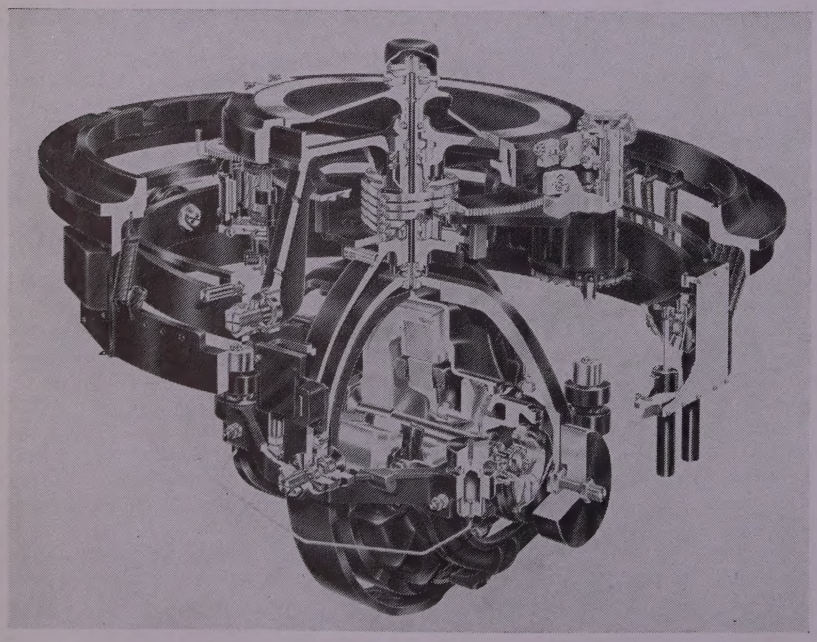
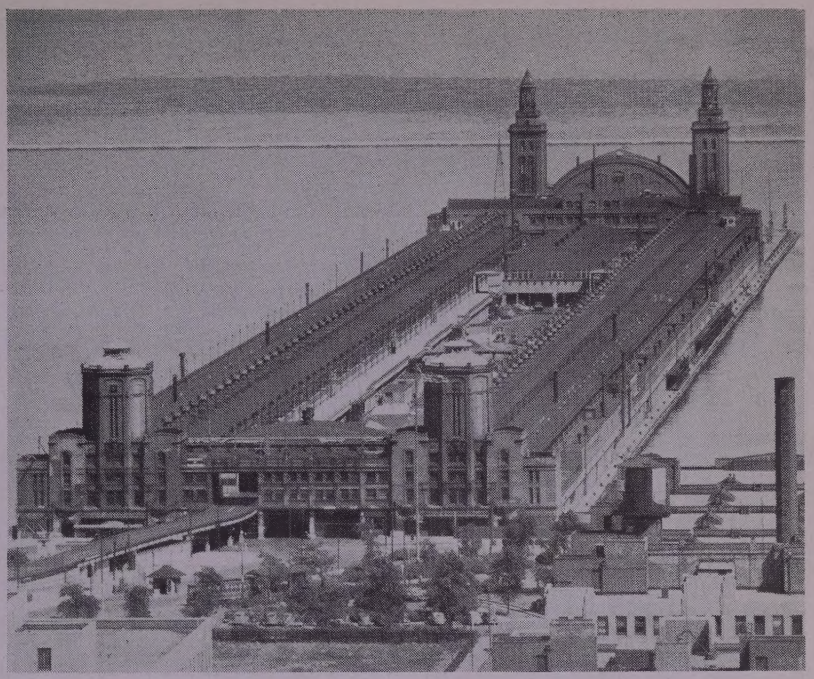


A cut-away view of the Sperry gyro-compass showing details of the internal assembly

The Pier Branch

By Francis Green, E.E. '48

Welcome to the College of Engineering, freshmen and sophomores of the undergraduate division at Navy Pier! Your student engineering magazine wants to acquaint you and the rest of our reading public with our engineering college and the Pier branch, its teaching personnel, and student personalities and 'characters,' if any. In one year the Pier has been built up to one of the 50 largest centers of secondary education in the United States with an enrollment of 4,000 students, and 276 faculty members. Most students come from within the city of Chicago and the faculty—far from being unknown and without reputation—include such men as Dr. Charles C. Caveny, dean of the undergraduate division, from Penn State, Dean Randolph P. Hoelscher, associate dean of engineering sciences, from the Urbana faculty, and several men from Northwestern university.



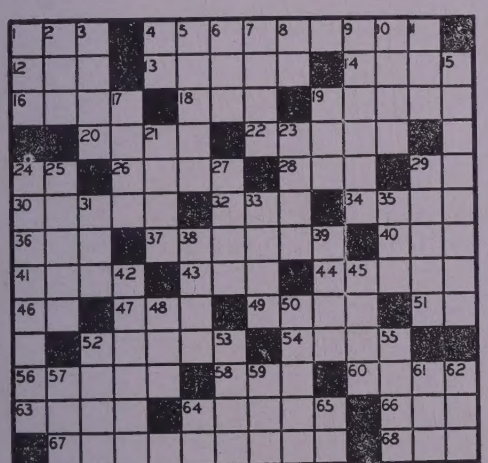
A familiar sight to "Pier Branch" students is Navy pier, the home of the University's undergraduate division at Chicago

With the exception of a dozen or so engineering sophomores and a proportionate amount of men in other divisions of the University, all students of last year are coming back to the Pier to embark on their second year of college. Several new instructors and 24 new courses on the sophomore level are now available.

This year the expansive opportunities of technical and non-technical extracurricular activities will go into full swing—a theatrical group, the "Pier Illini Productions," a student newspaper, the "Pier Illini," intramural athletics, and numerous activities for individual participation; such as, reading in the 10,000 volume embryo library, study of the indefinite loan of sculpture from the Art Institute, special exhibits at the Museum of Science and Industry, and most important of all a chance to join the student branch of the particular engineering society of your field. To those men and women who are interested in writing or applied business training, as well as a number of good times with a group of active engineering students, we extend our invitation to you to contact Mr. Ogden Livermore and initiate a branch of the *"Illinois Technograph,"* engineering student publication on campus, there at your division of the University of Illinois.

Among the Pier men who have come south to Urbana, are such GMOCs (growing men on campus) as the first editor of the *"Pier Illini"* newspaper, Bernard Weinstein, a new writer on the *Technograph,* Donald Johnson, and from what we hear 'Muriel Locke,' diminuitive, typical Navy Pier coed who announced her arrival at Urbana 'due to the adversity of the male Pier population'!

Crossword Puzzle



ACROSS

1. Spider's trap
4. He advanced a theory of electrochemical decomposition in 1805
12. In past time
13. American painter, invented the telegraph
14. German who produced his first telephone in 1861
16. Washing material, still scarce
18. Social gathering
19. Stain of disgrace
20. Freezing point of water, in the Centigrade scale
22. Motion picture actor, in "Caesar and Cleopatra"
24. Exclamation of triumph
26. Irrational number
28. Rumanian monetary unit
29. Keep in motion, said of a machine
30. Free negative atom
32. Monotonous routine
34. Irish dramatist, once employed in first English telephone exchange
36. Conquered
37. "The Wizard of Menlo Park"
40. Summer month: abbr.
41. First radio station to broadcast regularly scheduled programs, opened in 1920
43. Large simian
44. Stout, as one needing an electrical reducing machine
46. Mineral used in photoelectric cells: chem. symbol
47. Injure the surface of
49. Estimate
51. Junior's father: abbr.
52. Parts of churches
54. Electric amplifiers often help these people
56. Edges of a roof
58. Wing
60. Important part of a radio set
63. For all time
64. Floats, as on a liquid
66. Bean sauce
67. State of being upright
68. Female sheep

DOWN

1. Existed
2. Self
3. Ruth's second husband: Bible
4. Metric weight: abbr.
5. Moving part of a dynamo or motor
6. Source of a metal
7. Former Russian autocrat
8. Tellurium: chem. symbol
9. Planet for which the heaviest metal is named
10. Six: Spanish
11. Moral transgression
15. He patented an automatic telephone exchange in 1891
17. South American coin
19. Support for railroad tracks
21. Letter of old Norse alphabet
23. High voice
24. Englishman who devised an electric light in 1709
25. Positive electrode
27. Fall in drops
29. German who founded the mathematical theory of electricity
31. Important printing material
33. Consumer
35. Have: Scot
38. Defy
39. Memorandum
42. French physicist, developed the solenoid
45. Regular pulsation
48. Donkey
50. He produced the first electrotypes in 1839
52. State
53. Cut with a saw
55. This protects a circuit from overloading
57. Hail!
59. Falsehood
61. Arch of refracted light
62. Ample light prevents strain on this
64. City thoroughfare: abbr.
65. Kind of ship: abbr.

Industrial Ceramics Grows Up

By Karl Hilgendorf, E.E. '48

Ceramics is one of the oldest arts in the history of mankind. Although some phases have been shifting from the arts into industry, the war created one of the largest industrial applications yet found. This article deals with the application of ceramics to some of these war-created preblems.

The ceramics industry has made astonishing advances in the past few years. The glass industry in 1939 was worth 1/3 billion dollars. Glass products are as vital as any products the country produces — millions of light bulbs, X-ray tubes, lenses for microscopes, make glass important to scientific progress and industrial development.

Glass can withstand abrasion better than any metal. A colliery in Pennsylvania uses thick plate glass coal chutes in mines. Glass aircraft windows replaced plastics since pressure differential at high altitudes made plastic materials bend and pop out of their frames. Plastics offer no protection against ultraviolet rays.

The manufacture of glass is as ancient as civilization. The Egyptians, thousands of years ago, knew the secret of making emerald and cobalt glass, the Phoenicians were adept at blowing glass, and the Romans made the discovery of transparent glass. In 1900 an industrialist predicted that glass, as much as steel, would revolutionize the 20th century.

Foam glass—glass baked with carbon dust—is buoyant in water and can be used for life rafts. Fibrous glass in the form of glass wool insulation, continuous fibres for textiles, and non-inflammable drapes, were used by the Army and Navy.

Jet planes operate at temperatures of 2000° F and rise off the ground in 30 seconds. Special ceramic coatings make parts heat resistant. In planes, uncoated materials must be replaced in 50 hours. With ceramic coatings the lifetime of the metal was over 100 hours. Ceramic coatings are useful in coating turbo-supercharger parts.

Glass is unaffected by moisture and most acids. It can be made heavier than iron and lighter than aluminum. It was used in making the 200-inch reflector at Mt. Palomar observatory and has been drawn into fibres .023 inch thick. It can be as unbreakable as quartz and fragile as a Christmas tree ornament. There are 300,000 different ways of making it.

During the war the treasury department seriously considered making pennies of glass instead of hard-to-get copper.

The United States is today the leader in the quality and quantity of glassware and in the variety produced. With new uses of ceramics being discovered daily —from the textile industry to the building trades—the ceramics industry promises to grow by leaps and bounds.

Wartime Needs

Early in the war in Europe our intelligence department reported that flight paths of American bombers sweeping into Germany were being plotted by means of infra-red radiation detectors and anti-aircraft fire was being directed by similar apparatus. The infra-red rays emitted by the hot engines of our bomb laden Flying Fortresses and Liberators were a dead give-away as to the position of flying squadrons.

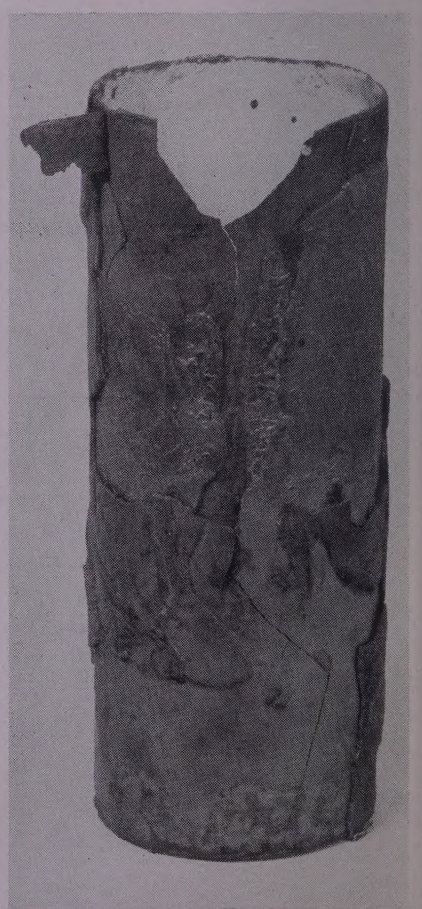
In July, 1943, Army Air corps officials from Wright field, Dayton, representing the Air Materiel command, dropped into the Ceramics building at the University of Illinois and asked Dr. A. I. Andrews: "Can you develop a ceramic material which will suppress infra-red radiation from the hot metal parts of our planes? Every plane gives away its location long before it reaches its target." Dr. Andrews' response was in the affirmative. He felt that ceramic materials could be found to solve this critical problem.

The laboratory investigation for special ceramic coatings which were to be applied to aircraft parts, such as collector rings and exhaust stacks, actually had a double purpose. The first was, of course, to suppress infra-red radiation. The second, equally important, was to unearth ceramic coatings which would protect metals from the rapid deterioration that they undergo in extremes of temperature.

During the following year, a critical review was made of ceramic materials available and tests were made on them continually. The tests determined heat resistance, thermal shock resistance, strength, radiation-suppressing qualities, and other factors.

It was found that any metal with a ceramic coating of the proper kind can be operated at temperatures higher than normal. In the tests on coatings placed between the flame and metal in exhaust stacks and jet engine flame tubes, it was found that the useful operating life of the metal part was increased several times. One specimen of steel was heated 450 hours at 1500° F. with no visible sign of corrosion.

Dr. R. D. Bennett, director of research in the ceramics department, was placed in charge of the project. Under him, R. K. Jursh planned and developed procedures and apparatus and, with the cooperation of the physics department, prepared test specimens.



Typical heat-corrosion in an unprotected pipe

The immediate result of the research was that metals had increased operating life, and due to this protection by a coat of ceramic material, cheaper metals could be substituted for more expensive metals. High grade steels were in demand by every branch of the armed forces; substitution of less critical materials proved a boon at a time when war production was at its peak.

Dr. Bennett says in a report: "With dense, relatively glassy coats serving to seal off metal from high temperature corrosion, the additional application of the more porous, relatively crystalline top coatings served to provide thermal insulation, radiation reflection, and radiation suppression. The net result was either a metal operating at a lower temperature or, often more important, higher combustion temperature with the metal temperature no higher than before.

The approach was to heat the specimen coated with various kinds of ceramic material and then evaluate the results through graphs. The Stefan-Boltzmann law shows how radiation and temperature are related. It is:

$$P = KET^4$$

where P is power radiated per unit area, T is the temperature in degrees Kelvin, E is the total radiation emissivity, and K is the Stefan-Boltzmann constant in watts per degree Kelvin per unit area. Planck's radiation formula gives the distribution of energy among the various wavelengths. It is:

$$J\lambda = (2hc^2/\lambda^5)\ (hc/\varepsilon^{k\lambda T^{-1}})^{-1}$$

where $J\lambda$ is the radiation intensity at wavelength λ
h is Planck's constant
c is the velocity of light
k is Boltzmann's constant
and T is the temperature in degrees Kelvin.

The Bouquer-Lambert law of absorption demonstrates that the ability of a body to transmit radiation is independent of the intensity of the radiation. It is:

$$J\lambda = J\lambda_o \varepsilon^{-kx}$$

where $J\lambda_o$ is the radiation intensity at surface toward the source
$J\lambda$ is the radiation intensity at a distance x
x is the distance from the surface toward the source along the radiation path
and k is the absorption coefficient of the transmitting medium

As a direct corollary of the Bouquer-Lambert law, it can be seen that each unit thickness of a homogenous medium reduces the intensity of the beam in the same ratio.

The Test Equipment

A tiny, specimen furnace, large enough to hold a 4 by 4 inch metal plate had a pyrex glass window to keep out convective air and was operated in connection with a variac which regulated the energy output. A Chromel-alumel thermometer was imbedded in the specimen metal and connected to a potentiometer.

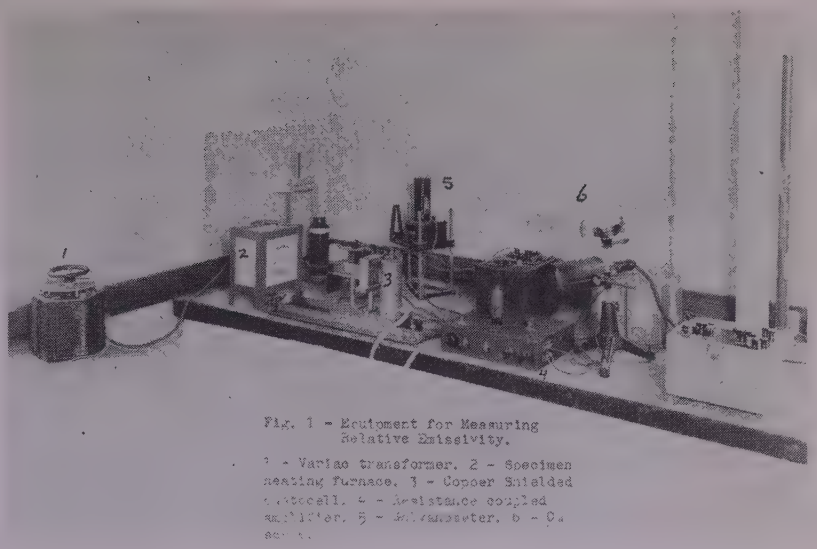


Fig. 1 - Equipment for Measuring Relative Emissivity.

1 - Variac transformer. 2 - Specimen heating furnace. 3 - Copper Shielded [illegible]. 4 - Resistance coupled amplifier. 5 - Galvanometer. 6 - Ga[illegible] scale.

The laboratory arrangement of the equipment used to measure the relative emissivity of coated materials

A photoelectric cell, sensitive to radiation up to 1.2 microns, changed radiation to electrical energy which was measured through a reflecting galvanometer. Deflections on an attached focused scale gave a direct measure of radiant energy.

Two types of filters were used. A Corning, black glass filter, which cut off infra-red emission wave lengths below 0.75 micron, and a glass filter cell (with $CuCl_2.2H_2O$), which was open to radiation below .7 micron, were satisfactory.

Preliminary tests indicated that all grades of steel showed the same absolute emissivity over a given temperature scale. As the temperature is raised, oxidized steel reaches a total emissivity of 95%. Stainless steel was selected as the test specimen in all remaining work of the investigation. Readings of the radiant energy from the coated steel were taken at 50° intervals over two main temperature ranges—800-1000° F. in the infra-red band and 1100-1800° F. in the visible and invisible radiation bands.

A number of variables were considered: particle size, coat thickness, firing time, temperature, and types of bonding glasses. Bonding glasses with different capacity to transmit radiations were correlated to the other variables. The per cent of bonding glass was kept low to keep the coat thickness down as much as possible. Each first coating 14 mils thick was fired on the steel plates before the test metal received its coating of the ceramic material tested.

Nineteen representative materials, among which were diaspore, uverite, feldspar, lepidolite, cobalt dioxide, manganese dioxide, and olivine were tested with filters over the 800-1600° F. range to determine the amount of emissivity.

The following is the formulation for base coat No. 32-16 at 4 mils thickness:

Quartz	24.3%
Potash feldspar	34.8
Borax	23.8
Sodium carbonate	6.5
Sodium nitrate	4.2
Fluospar	3.7
Cobalt dioxide	0.5
Nickel oxide	0.5
Manganese dioxide	1.5

A mill batch of the above frit number 32 was made up as follows:

Frit number 32	65
First grade diaspore	35
Borax	0.75
Water	50.00

The frit materials were mixed and melted to quiet fusion and the melt was then quenched in water and dried. After the mill batch was ground, a 100 gram slip sample was passed through a 200 mesh screen and 4 grams of residue remained. The remaining slip was applied to the annealed metal specimen by dipping, and then fired for 10 minutes at 1750° F.

Testing Procedure

The specimen was placed in the furnace with a top coating facing the photoelectric cell, and the temperature was raised gradually to 1600° F., slowly lowered to 800° F., and then raised again at the rate of 10° a minute to 1100° F. with readings taken every 50°. At 1100° the sensitivity of the galvanometer was reduced to keep the deflection on scale and filters were changed. Additional readings were taken up to 1600° F.

Analysis revealed that in the low tem-

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Quality Control . . .

Industry's Watch Dog

by Jerry Mathews, M.E. '47

A relative newcomer to industry, the field of quality control is the subject of this article. Developed by means of statistical mathematics, quality control is proving itself to be as effective as 100 per cent inspection and yet is much less expensive and troublesome.

The progress of accuracy in machining has increased geometrically in importance since the beginning of the machine age and along with it has grown the responsibility of making machines which can produce parts within very narrow limits. It is not uncommon to see manufactured parts with a tolerance of .000006 in. It would be economically impossible to discard machines which, after normal wear, fail to produce the accuracy demanded. Consequently, the practical method is to measure the parts as they come off the machine, discard those beyond the limits, and if necessary, shut down the machine for readjustments when it consistently fails to produce parts within the specified limit. At best this system, if not wasteful of material, slows down production—a violation of one of the ten commandments of a business enterprise.

It took two world wars and a University of Illinois graduate to partially solve this problem through "quality control." At least a good attempt is being made by many companies to utilize the method of quality control to cope with the dilemma posed by the need for rapid production along with accuracy.

rinciples Explained

The Federal Products corporation, a manufacturer of precision measuring instruments, has published a "primer" explaining the theory of quality control in the layman's language. The following is a condensation of this explanation of the principles of quality control.

"If 50 pieces are taken from the work of a machine where the o.d. has been turned and if the pieces are measured individually with an indicating gage for this outside diameter and then classified by actual dimension (a sort of selective assembly operation), in other words laid out in rows by actual dimension, a result similar to that shown in Fig. 1 will be obtained.

"A group of pieces dimensionally classified in this manner make what is known as a Frequency Distribution, illustrating the frequency of occurrence of certain dimensions and their distribution among the whole. The curve itself is called a Frequency Distribution curve.

"It is characteristic of pieces classified and distributed according to their dimensions that the largest group would fall close to the mathematical average of the entire assembly.

"Furthermore, it has been found that a Frequency Distribution can be divided into six zones mathematically equal in width. Thus a practical use of the Frequency Distribution becomes available because it has been determined that the number of pieces ordinarily lodging within each of the strips represents percentages of the total. Carried to an extreme, the Frequency Distribution procedure could resemble or equal 100% inspection.

"In the actual application a sampling procedure is adopted and a chart system replaces the frequency distribution. Rather than sort over the entire 50 pieces, small samples, such as five pieces at a time, are taken more or less regularly from the work as it progresses, and

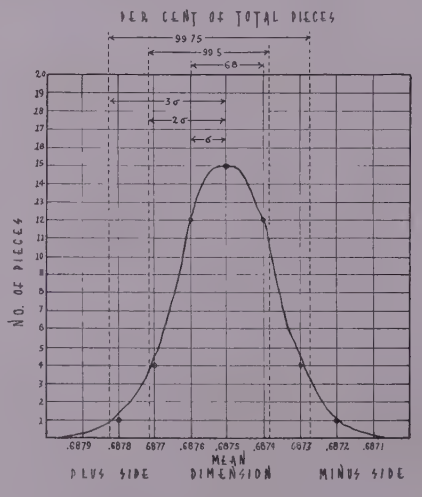

Figure 1
A Frequency Distribution Curve

certain resulting observations are plotted on a control chart, as shown in Figs. 2 and 3.

"In order to determine the value of 3δ, mathematicians have developed formulae by which the 3δ value can be calculated from a quantity known as "range" is the difference between the greatest and smallest dimensions observed in each sample taken. Fig. 3 shows a chart on which the 5 readings from each of the samples are plotted in proper position. It illustrates for each sample taken the highest and lowest reading and the spread, or range, between them, as well as the variation in range from sample to sample."

The Application of Theory

From the foregoing principles quality control has come into existence. To see how these principles are put into actual practice, consider the following example.

Usually five pieces are selected at random during definite intervals by an inspector or operator right at the machine. Each piece is measured and the measured value recorded. An average of the five readings, called $\overline{X}$, is recorded along with the largest and smallest readings. The difference between the largest and smallest readings is called the range and represented by $\overline{R}$. Generally between 10 and 25 such samples are taken from which the overall averages of $\overline{X}$ and $\overline{R}$ are obtained. From these values it is then possible to calculate the control limits by means of the following formula:

$$c.l.=\overline{X}-A_2\overline{R} \text{ and } \overline{X}+A_2\overline{R}$$

where A_2 is obtained from the table below

No. Pieces	5	8	10	12	15
A_2	.577	.373	.308	.266	.223

To obtain the control limits for the range, the following formula is used:

$$\text{Upper } c.l.=D_4\overline{R} \quad \text{Lower } c.l.=D_3\overline{R}$$

where D_3 and D_4 are found from the table below:

No. Pieces	5	8	10	12	15
D_4	2.114	1.864	1.777	1.717	1.652
D_3	0	.136	.223	.284	.348

With the control limits set up then, the process of measuring five pieces of work periodically is continued and the averages of $\overline{X}$ and $\overline{R}$ are plotted on a control chart. When either of these averages falls outside the established limit, it means that that particular sub-group of five has gone "out of control"; and either a readjustment of the machine or a recalibration of the measuring instrument is necessary. At least it is known that something has gone "haywire" with the process and that it's time to make a check. It also means that a 100% inspection of all the parts produced after the preceding sub-group is necessary.

That the speed and quality of production is directly dependent upon the method of inspection is not difficult to

ee. It should also be apparent that the quality control method of inspection based on the principles of Frequency Distribution permits a considerably greater production speed than the 100% inspection method. In actual practise the inspection method adopted is a compromise between the required accuracy and economical operating speed. For example, in a process with fairly large limits a 10 or 15% inspection method may be adopted with reasonable accuracy which

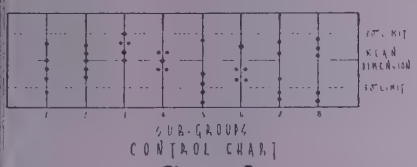

Figure 2

also permits the process to be operated at a speed consistent with economy. As the limits of the process become smaller, the method of inspection must, of necessity, become correspondingly larger to insure the quality of the product. For limits smaller than a certain value a 100% inspection method is mandatory, because the increased production speed gained by any lesser method is more than offset by the number of defective parts which are undetected. By the use of the principles of quality control the necessity for 100% inspection is eliminated and at the same time the accuracy of the work is maintained. Of course this is the big selling point of quality control—"accurate guess work." With the formulae and constants developed by mathematicians for the quality control method, however, the guess work is reduced to about a 99.99% calculated risk.

Mathematical Angle

One of the more prominent mathematicians responsible for the development of quality control is Dr. Walter A. Shwart of the Bell Telephone Laboratories. Mr. Shwart was graduated from the University of Illinois in 1913 and received his Master's degree here in 1914. He completed his work for a Ph.D. at the University of California in 1917.

It is very likely that Mr. Shwart became interested in the subject of quality control through his work with Bell Telephone, for in 1918 it became his duty to establish head sizes for aviation radio helmets. In 1924 he actually began studying sampling plans to be used in the inspection of quality. His problem then was—how large a sample should be taken in order to justify the acceptance or rejection of a given production lot on the basis of these samples? The statistical control chart, described previously, was introduced for this determination and is now used both here and abroad by many corporations.

The British have added a new section to the Royal Statistical society concerned entirely with quality control. In the United States the war department during World War II requested the American Standards association to organize a committee for the purpose of sponsoring the application of statistics to quality control. It was this action that has been largely responsible for the present day interest and popularity. As a further supplement to the original training offered by the war production board, a series of papers called "Quality Control Reports" were also published in which were shown many illustrations of the application of quality control.

Quality Control Succeeds

In one report the John Deere company published an interesting account of the direct application of quality control to a production problem arising in their shops. In the manufacture of piston pins the three final operations in the production procedure consisted of:

1. rough centerless grinding
2. plunge (or stop) centerless grinding and lap
3. polishing.

It was found that after leaving the rough centerless grinding operation considerable trouble had arisen with uneven flow of parts and scrap work. To correct this trouble, it was decided to utilize the principles of quality control; and to do this, necessitated a conference with the superintendent and supervisors.

Next it was necessary to select and train individuals for patrol inspection and thoroughly acquaint everyone involved with the procedure required to carry out the quality control method. This preliminary preparation was considered absolutely necessary because of the inertia in getting the operators to change over from the old procedure to the new one.

After the system had been set up, it was found that the plunge centerless grinder was turning out the pins on the high side of the tolerance; and as a result a number of them were oversize. By proper adjustment of the machine the average size was brought down closer to the mean dimension, but the range still continued at an unsatisfactory level. A control chart placed on the preceding, rough centerless grinders indicated that this operation was not functioning properly, and a check-up revealed that the operator was not making the prescribed number of passes through the grinder. After correcting this condition and making a few machine adjustments, the operator was then able to easily turn out the pins according to specifications with only sub-group checking.

As a check on the accuracy of the quality control method, 1800 pieces were given 100% inspection and found to all fall within the specified tolerance. The control charts, however, showed that four points fell below the lower control limit for averages. This downward trend in the averages indicated that even though all of the pieces were within the tolerance, some operation was still "out of control." When that particular trouble was located and corrected, complete control was maintained for the rest of the run; and all of the pieces produced were found to fall more closely to the mean specification.

From the foregoing discussion it can readily be seen that the advantage of

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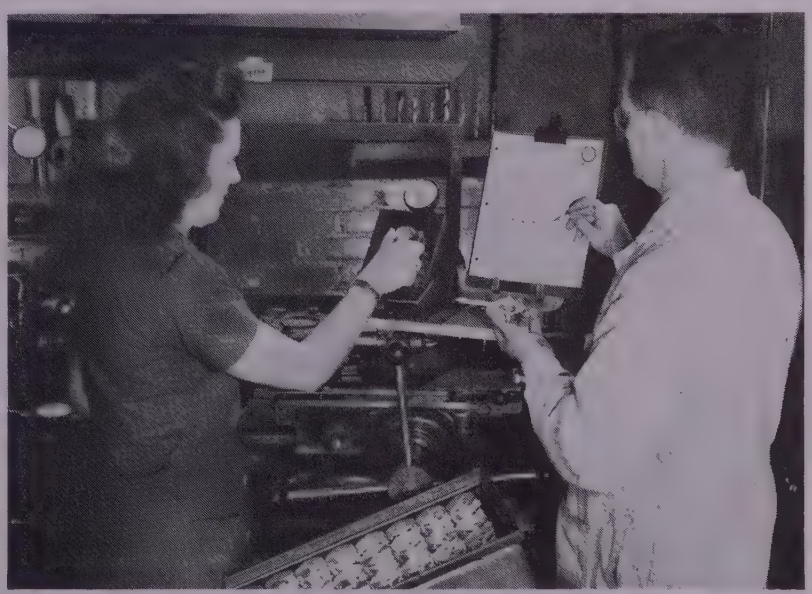

Figure 3
A sub-group control chart shown in actual use on the machine floor

Illini in Action . . .

THE STORY OF CARL MENZEL

by Florian Kaitis

Do you know that the number of small air bubbles in concrete determines the durability of that concrete? Concrete with less than a certain amount of air weathers badly. Concrete with greater amounts of air resists frost action, but its strength is decreased. A problem is raised—how to get enough air into the concrete without getting too much. Putting the air into the concrete is simple. Controlling the amount of air is tricky. Before you can control it, you have to measure it. That is the assignment Mr. Carl Menzel, research engineer of the Portland Cement Association, received.

After my discharge from the Army, I went to work for the Portland Cement Association. That was when I met Mr. Menzel—I became his assistant. In the next few days I learned a great deal about air-entrained concrete. I learned that between three and five per cent of air is best for durability and strength. I learned that it is easy to adjust the amount of air in concrete by adjusting the mix. I also learned to qualify that last sentence—it's easy to adjust the amount of air in concrete, if we know how much air was in the last batch mixed. Then I learned that measuring the amount of air in the concrete was hard, and that our job was to devise a "Practical Field Method for the Determination of the Air Content of Fresh Concrete."

Initial Difficulties

There were three general methods in use a year ago for measuring the air content of fresh concrete. In one, the "gravimetric" method, the weight of a cubic foot of the fresh concrete was obtained and compared with the theoretical air-free unit weight of the same concrete. This comparison gave an "air content." In another method the air was removed from the concrete by "washing," and the loss of volume in the process represented the air content. In the third method the concrete was put under pressure, and through measurement of the volume change under that pressure, the air content of the concrete could be found.

Serious objections to each method were made, the most serious of these being inaccuracy. An experienced man could judge air content more accurately "by guess and by gosh" than by any of the three.

For instance, with the most highly approved method, the most "exact" method—the gravimetric—the weight of an accurately measured volume of fresh concrete was needed. To be fairly certain of the amount fair, an accuracy of about 3 in 10,000 was needed — an accuracy common in the laboratory, but impossible in the field where the test was to be used.

Mr. Menzel sat down and did some thinking. First he listed the disadvantages of each method (at that time there were few advantages for any of them). Then he started devising ways of removing the faults.

The almuni department, Illini in Action, has been devoted this time to the story of one man, Carl Menzel '17. This story deals with the problems he encountered in handling an assignment he received as a research engineer for the Portland Cement Association. The outcome of his work—a pressure testing unit for determining the air content of concrete—was reported in the May 1947 issue of the Technograph. This story is the saga of headwork, elbow-grease, and grief behind its development.

The gravimetric method was discarded at the start. The composition of each tested batch had to be known—the exact amounts of water, sand, cement and gravel in the batch had to be known with an accuracy that is impossible on a road job where conditions seem to change without apparent reason. The gravimetric method also involves computations which are too lengthy for the field, where test results are needed "immediately" if not sooner.

'Washing' Method Cumbersome

Now let's follow his reasoning with one of the other methods, the "washing" method. The accepted technique of the washing type of test was devised by Mr. Benham of the Indiana Highway department. It consisted of measuring the weight of a cubic foot of fresh concrete and then immersing the sample in a large amount of water. The concrete was stirred around until the mortar from the fresh concrete became so thin and diluted with water that it couldn't hold any of the air, and the air escaped. Since the air was released, the volume of water and concrete decreased. With a careful volume measurement and another weighing, sufficient data had been gathered to determine the air content. After about fifteen or twenty minutes of pencil work (slide rule isn't accurate enough), the inspector might be able to calculate the air content.

In all, three weighings and three volume measurements are needed with the "Indiana" method. The scales must be rugged enough to take the abuse found on a construction job. Scales rugged enough to withstand the hard usage are not accurate enough to be used with this test. Two of the volume measurements are on a water surface with a hook-gage. The last of these measurements is always confused by the presence of a thick scummy foam composed of cement particles and the air-entraining agent used. Combining the inherent inaccuracies of the hook-gage and the scales with the probable errors in calculations, the Indiana method was little better than guess work.

The Plot Thickens

Carl Menzel considered the difficulties and their solution. The scales led to inaccuracies. Discard it. The hook-gage gave incorrect answers. Discard it. The scum caused difficulties. Remove it. Mixing the concrete and water was hard physical labor—labor the average inspector might shirk. Lessen it. Computations were difficult. Eliminate them.

The general solutions of the problems were easy. The details of the problems were not. Easy to say "remove the scum." But how? Well, the thing that held the scum and foam together was the air-entraining agent. There must be something to dissolve it. Scores of solvents were tried. Finally one was found that almost "ate it up." There was a problem solved after only a month or so. At the same time others were being investigated and whipped. Finally the "rolling method" was evolved. There was little resemblance left between the rolling method and the Indiana method.

While research was proceeding on the "washing" type of test, the "pressure" method was taking shape. Boyle's law gave a relation which should easily tell the air content of the fresh concrete if its change in volume under a pressure change was measured. Boyle's law seemed to be incorrect in this case—at least there seemed to be no correlation. The sand and gravel used in making concrete is full of small pores. These pores are usually filled with air—air which has no affect on the durability, but which has a varying affect upon the indicated air content of the concrete. After a "porosity correction" factor was determined and applied, the pressure method became a possibility.

(Continued on Page 30)

a TELEPHONE engineer

Here we see his tools—
His head
And his hands.
He may have emphasized electronics or mechanics
Or some other of the many engineering specialties,
But, more important,
He knows his mathematics and science.
He has the engineer's viewpoint and approach—
The ability to see things through.
He's a lot of engineers rolled into one.

★ ★ ★

He's happy in his work
And his future looks good.
He's a telephone engineer.

BELL TELEPHONE SYSTEM

The Engineering Honoraries and Societies

I.A.S.

The annual spring picnic was held on May 16 at Hessel park in Champaign. Rain kept the attendance down to 40 members, wives and girl-friends, but failed to dampen the spirits and appetites. Baseball was the main form of recreation. Following the game, a picnic supper was served.

The officers elected for the summer semester were: Jack McGuire, president; Louis Glover, vice-president; and Paul Klevatt, secretary-treasurer. Prof. R. W. McCloy is the faculty adviser.

The first meeting of the summer was held July 2 on Diamond No. 3. A baseball game was the main topic and Paul Klevatt's team outpointed Prof. McCloy's team. Refreshments were served following the game and a short business meeting was held. The following men were named to the meetings committee: Louis Glover, chairman; Ralph Fidler, R. S. Chubb, and Robert Kelly.

The second meeting was held August 6. Prof. H. S. Stillwell, head of the department of aeronautical engineering, spoke on the topic, "The Aircraft Industry." He pointed out that the aircraft industry reached the low point of employment in 1947 due to cut backs on government appropriations and small commercial requirements. Even so, there will be enough jobs for all who want them. Next year points to an increase in employment. He also discussed the new training facilities to be inaugurated at the U. of I. These include a supersonic wind tunnel, an engines lab, a structures lab, and a graduate program, all to be in operation soon.

The third meeting was held August 20 on Diamond No. 3. The sole object was baseball. Ed Spuhler's team downed Paul Klevatt's team by a score of 11 to 10—the game ending in darkness.

The last meeting of the summer was held Sept. 10 with movies and election of officers for the fall semester. At that time the points of the proposed Engineering Council was brought out.

M.I.S.

With plans under way to hold a membership drive right after registration, the Mineral Industry Society will have their first meeting for this purpose during the first week of school. Although inactive during the summer, the society plans to start off the fall program at the first meeting with a discussion of plans to send as many members as desire to the National Metals Exhibition and Congress in Chicago on October 22 and 23.

The activities of the society will be guided by the following officers who were elected at the last meeting of the spring: Leland House, president; Lynn Rowells, vice president; Margaret O'Donnell, secretary; and W. W. Berkey, treasurer.

A.S.C.E.

"The Golden Gate Bridge" was the title of the movie shown on June 19, at the first meeting of the summer term. The film portrayed some of the construction and maintenance problems of the bridge.

A smoker was held at Latzer Hall on July 17. Prof. Babbitt gave a short talk and introduced the faculty. Jim Keith, president, then introduced our guest speaker, Frank M. Amsbary, who spoke on the advantages of belonging to a professional society.

Prof. Shedd gave an explanatory lecture in connection with the film "The Tacoma Narrows Bridge," at a meeting in Gregory Hall on August 7. The movie was very spectacular and almost unbelievable. As Prof. Shedd commented at the beginning of the meeting, "I've seen this film over 50 times and I still can't believe it possible."

On September 17, the student chapter and the central section of the A.S.C.E. held a joint meeting at a dinner banquet in Latzer Hall. Mr. Hastings, president of the parent society, was the guest speaker.

The officers for the summer term were James M. Keith, president; James M. Wolfe, vice president; Barbara Schmidt, secretary; and Robert E. Kronst, treasurer.

A.I.E.E.-I.R.E.

The combined student branches of the American Institute of Electrical Engineers and the Institute of Radio Engineers will open the fall activities with an orientation program. All sophomore, junior, and senior electrical engineers are cordially invited to attend this meeting to familiarize themselves with these organizations. Dr. William L. Everitt, head of the electrical engineering department, will address this meeting on the importance and advantages of membership in technical societies.

Past experience has shown that electrical engineering students often have not become active in the A.I.E.E.-I.R.E. until late in their junior or senior year. This orientation program will attempt to stimulate interest at an earlier time so that underclassmen will avail themselves of the opportunities offered by an extra-curricular engineering activity.

Eta Kappa Nu, electrical engineering honorary fraternity, will participate in the program by presenting an award for scholastic achievement to the highest ranking, first-semester junior in the department. The purpose and function of Eta Kappa Nu will also be explained to acquaint students with the opportunities of association with this group.

During this past summer the combined A.I.E.E.-I.R.E. sponsored several events. A pre-war custom was revived when over two hundred students and faculty attended a department picnic. Highlighting the afternoon's activities was the traditional student-faculty softball game. The winner was awarded the A.I.E.E.-I.R.E. trophy which is now on display in the electrical engineering laboratory. The awarding of this trophy will be an annual event at the department picnic each spring.

Another open program sponsored by the A.I.E.E.-I.R.E. was the "Previews of Progress" demonstration given by General Motors corporation in the Gregory hall theater on July 24. Over four hundred students, faculty, and guests attended the show which demonstrated examples of current scientific research.

Programs planned for the fall semester include speakers from technical organizations such as the General Electric company, Bell Telephone company, and others. In addition A.I.E.E.-I.R.E. members will travel to Chicago early in November to attend the A.I.E.E. and electronics conferences. Several social activities have also been proposed for the semester but are not yet scheduled.

A.I.Ch.E.

Since the summer enrollment did not warrant any meetings, the student branch of the American Institute of Chemical Engineers remained inactive. The final meeting last spring was the annual picnic held on May 10 at the County Fair grounds. At this meeting the officers elected for the 1947-48 school year were Donald Hornbeck, president; John R. Mitchell, vice president; Dale Glass, secretary; and Edwin F. Dyer, treasurer.

During registration a membership drive will be conducted among the stu-

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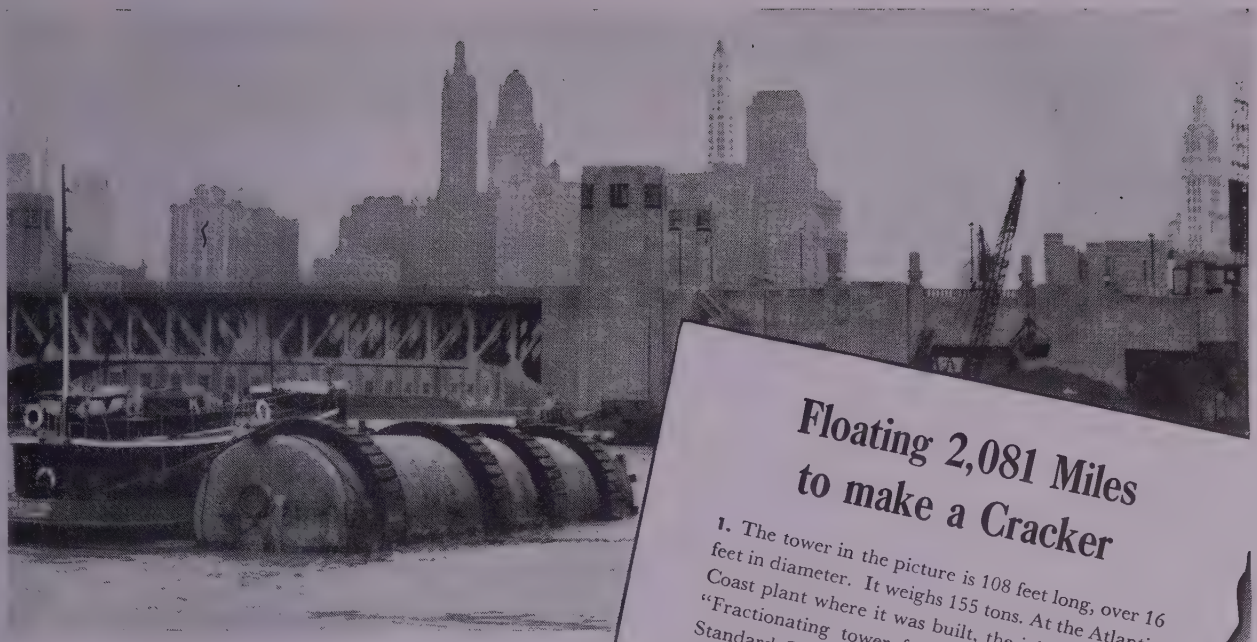
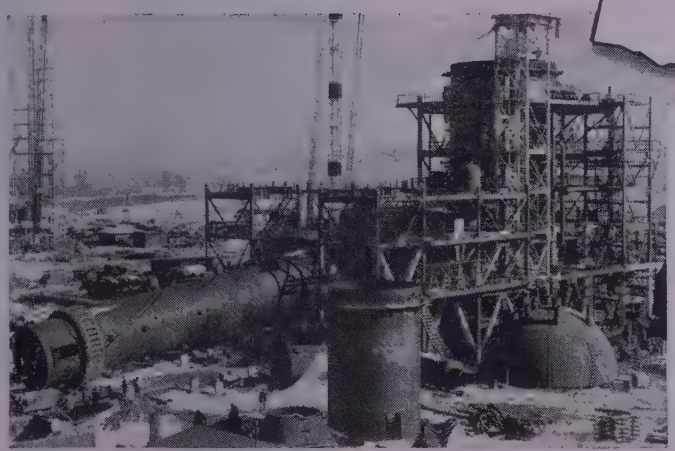
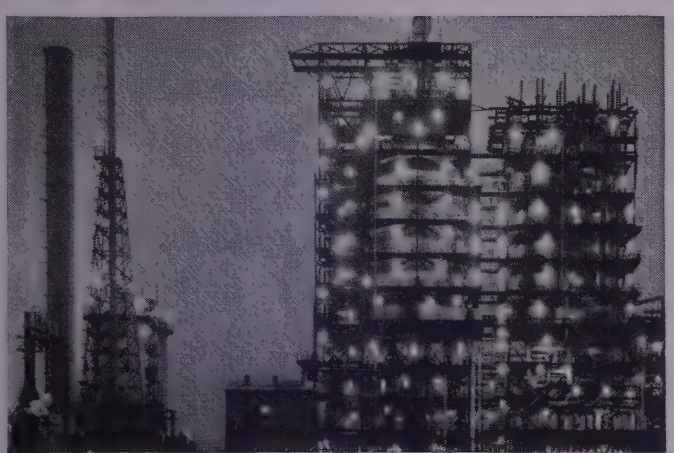


Floating 2,081 Miles to make a Cracker

1. The tower in the picture is 108 feet long, over 16 feet in diameter. It weighs 155 tons. At the Atlantic Coast plant where it was built, the job ticket read, "Fractionating tower for catalytic cracking unit, Standard Oil Company (Indiana)." Too big to be shipped overland, it had to go by water to Standard's refinery at Sugar Creek, Missouri, near Kansas City—a matter of 2,081 miles!





2. The tower was timber-cribbed and floated, towed up New York Harbor and the Hudson River, across New York State by canal. A tug took over the towing job through Lakes Erie, Huron and Michigan, riding out a storm en route. Then the tower was loaded on a barge to complete its journey via the Illinois, Mississippi and Missouri Rivers. This winter at Sugar Creek, the cat cracker of which this tower is part goes on stream, joining similar units already operating at other Standard refineries. It has a charging capacity of 25,000 barrels a day!

3. Like our Burton Stills in 1913 and continuous units of 1932, catalytic crackers are milestones in petroleum progress. Today at Standard, the industry's ablest engineers and research men are developing new . . . and better processes and products. Men of the same type are coming from leading colleges of science and engineering to start work at Standard. Here they find unexcelled technical facilities for research and design. If you want a career with splendid opportunities to advance and make real contributions, you should get to know Standard better.

Standard Oil Company

(INDIANA)

910 SOUTH MICHIGAN AVENUE, CHICAGO 80, ILLINOIS

STANDARD SERVICE

Introducing . . .

by John Shurtleff

WILL J. WORLEY

Up three flights of stairs in Talbot laboratory, the name Worley can be found on the door of room 321a. Inside sits quiet, sandy-haired Will J. Worley, an instructor of T.A.M. 1, 2, 3, and 63. He seems to be right at home with a testing lab down the hall, a slide rule in his hand, and the sound of machines at work.

Mr. Worley is a native of Illinois, being born in Gibson City, August 2, 1919. After spending eight years in a country school and one year at Drummer Township High School in Gibson City, he came to Champaign. Finishing high school here, he enrolled in the University in mechanical engineering and graduated in 1943. He received his M.S. in Theoretical and Applied Mechanics in 1945. At the present he is working for his doctor's degree in engineering while teaching.

Outside of his regular work, he is interested in radio circuits and also in the application of electrical and electronic equipment to industrial control. He devotes the rest of his spare time to hunting and a stamp collection.

Mr. Worley is now helping with tests of plastics and plastic laminated material. He has spent the last two years on steel, making tests of static tension, high velocity impact, impact tension, etc. The purpose of these tests is to determine the effects of temperature, rate of straining, strain aging, stress concentration, and state of stress in producing brittle fracture of steel.

His most recent development in the field of testing devices is an adoption of the Baldwin Southwark portable strain indicator to dynamic tests. Mr. Worley explains, "This adaptation was developed to obtain an easily available commercial unit for repeated dynamic strain measurements. The procedure involves the use of a standard Baldwin Southwark portable strain indicator and a cathode-ray oscilloscope. The oscilloscope is used in the circuit as a null balance indicating device."

Mr. Worley is a member of Pi Tau Sigma, Sigma Xi, Pi Mu Epsilon, the American Society of Mechanical Engineers, the American Society for Testing Materials, the Society for Experimental Stress Analysis, and the American Society for Engineering Education.

When asked for some comment on his teaching, he replied, "I always recommend to my students that they read an article called 'The Unwritten Laws of Engineering' by W. J. King. Every prospective engineer will get something out of it." He also stated that his favorite subject from the standpoint of teaching is T.A.M. 2.

Well liked by his students and fellow engineers, Mr. Worley is making some really fine contributions to the field of engineering.

MARY E. WELCH

There is probably not a single student in the College of Engineering who has not looked many times across the desk in 300 Engineering hall at Mrs. Welch's smiling face. And across this desk she is asked any conceivable question on engineering.

While waiting just a few minutes to see her, we heard a student ask whether he had enough hours to register with sophomores or juniors; another needed her help in making out his study list for the following term; yes, even a telephone caller wanted to know if he was still on probation. Only part of the inquiries, however, need the use of her complete files on each student's scholastic record.

Graduated from New Canton High School, Mrs. Welch spent most of her married life in Rockport near New Canton. After the death of her husband, she attended the Illinois Business College at Springfield and worked a little in Springfield after graduating.

Coming to Champaign-Urbana in December, 1940, Mrs. Welch worked in Dr. Bailar's office until August, 1943, on the records of freshmen chemistry students. She then began her present position as senior record clerk for the College of Engineering. Although an occasional engineer uses "damn" or "hell," they impress her as being well-mannered and knowing what they want out of school.

Mrs. Welch has played quite a bit of bridge, but for relaxation she enjoys reading most of all, with gardening running a close second. But we are sure if you ever go into 300 Engineering hall, you will agree that Mrs. Welch's graciousness shows an intense interest in people too.

WILBUR TUGGLE

"When the other boys wanted to be firemen, I wanted to be an engineer . . . always did," quietly stated Wilbur Tuggle. As a junior in civil engineering, Wilbur is rapidly approaching his boyhood goal.

He came to the University of Illinois because he believes that it is one of the finest engineering schools in the country and because it is far enough away and still close enough to his home town, Chicago.

After graduating from Wendell Phillips High School in February of 1941, Wilbur worked for a year to finance his education. However, Uncle Sam had other ideas for him, and after completing his freshman year, he left for service. The next thirty-one months found Wilbur in the Pacific Transportation Corps, stationed in New Guinea, the Philippines, and Japan. After his re-

(Continued on Page 32)

WILBER TUGGLE

Ultrasensitive RCA Television camera tube cuts studio light requirements 90%

Television finds drama in the dark — with new RCA studio camera

Now television becomes even more exciting as lights are dimmed, and the camera reaches deep inside studio shadows to capture action as dramatic as any on stage or screen . . .

A new studio television camera—developed by RCA scientists and engineers—needs only 1/10th the usual amount of light.

The super-sensitive eye of the new camera is an improved Image Orthicon Tube . . . of the type once used only outdoors. With it, studio broadcasts are sharper, clearer—and since so little illumination is needed, heat in the studio is sharply reduced. No more blazing lights!

Such improvements come regularly from research at RCA Laboratories, and apply to all branches of radio, television, electronics, and recording. These improvements are part of any product bearing the name RCA or RCA Victor.

• • •

When in Radio City, New York, be sure to see the radio and electronic wonders at RCA Exhibition Hall, 36 West 49th St. Free admission. *Radio Corporation of America, RCA Building, Radio City, New York 20.*

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Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
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- Development and design of new recording and reproducing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to National Recruiting Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RCA **RADIO CORPORATION of AMERICA**

GEORGE R. FOSTER
Editor

FRANCIS P. GREEN
Ass't Editor

EDWIN A. WITORT
Ass't Editor

the Illinois Technograph

STOP! LOOK! THINK!

Do you remember how many laborious hours you have spent from time to time trying to decide on what kind of a job you want? The process started 'way back when you were in knee pants and insisted that the life of the corner policeman directing traffic was the one for you. Since then it probably has run through quite a gammut of jobs until, as you grew older, your taste in type of work finally settled into a more practical field.

Of course, some people never reach a final decision, and others do not decide definitely until after they graduate and start hunting for jobs, but in any event most people have at least a general idea as to the type of work they want. Having made this momentous decision the average person then sits back with a self-administered pat on the back and begins to prepare himself for the job by going to school. Since the item of deciding on the appropriate technical preparation has already been considered in planning the various curricula, the average student is fortunately spared the necessity of deciding what technical courses his education should include. Instead, most people promptly pitch into four years of hard work and equally promptly become lost in a maze of details relating to their particular line of study. An occasional few may even be far-sighted enough to realize the value of the experience to be gained from participation in extra-curricular activities.

In any event it is indeed rare that a student will have even considered—let alone reached a decision—on the third great problem which usually rears its surprising head about the last half of the senior year; i. e., "Whom shall I go to work for when I've finished school?"

Whether the student decides that he wants to work for himself or someone else is, in itself, unimportant. What *is* important is that the student should not leave this problem for a last-minute decision based solely on the consideration of remuneration. The answer to the question is, of course, up to each individual, but happiness and satisfactory performance in one's job is not achieved unless all the factors affecting the choice are considered.

To try to cover all the phases of future job prospects and point out all of the criteria used in making a sensible selection of employer is a pretty tough order, but the *Technograph* is going to attempt to tackle part of it. Since the larger, nation-wide companies are not only well known to most students, but also well publicized in our pages, it is going to be our additional aim in this year's issues to publicize a hitherto little-used and less well-known field of employers—the local manufacturers located throughout the State of Illinois.

It is true that many men eventually work into these smaller industries, but as yet, very little has been done to establish contact between them and the graduating engineer. It is felt that the student, in considering all the possibilities in selecting a suitable employer, is overlooking a fairly large, potential field just through lack of knowledge and publicity. To accomplish this purpose, the *Technograph* is planning a series of articles about several representative industries designed to acquaint the student with the type of work found in smaller organizations.

It is sincerely hoped that this series will not only open up a new field to you, but will also help to overcome mental inertia so that you will begin to consider this subject with more than just a passing thought and will be able to walk into an interview with other questions on your tongue than "How much will you pay me?"

Du Pont Digest

Items of Interest to Students of Science and Engineering

Fundamental Engineering Studies

Studying product development in an experimental rotary dryer. H. J. Kamack, B. S. Chemical Engineering, Georgia Tech. '41; F. A. Gluckert, B. S. Chemical Engineering, Penn State '40.

Inspecting the interior of experimental spray dryer after a run. W. R. Marshall, Jr., Ph.D. Chemical Engineering, Wisconsin '41; R. L. Pigford, Ph.D. Chemical Engineering, Illinois '41.

In a company like Du Pont the diversity of chemical operations is great and the investment in equipment is high. In addition to the engineering work done in the ten industrial departments, the responsibility for design and construction of manufacturing plants is undertaken by the central engineering department, which also maintains an engineering research laboratory. This laboratory is staffed by chemical, metallurgical and mechanical engineers, and physicists, whose function is to carry on fundamental and pioneering-applied research to develop new methods of processing and equipment designs; improve equipment, materials of construction, and methods of measurement and control; and establish fundamental relationships in unit operations and unit processes.

For example, a broad project was undertaken to study the fundamentals of rotary drying. A principal objective of the study was to learn the effect of the operating variables on the volumetric heat transfer coefficient. Of the numerous variables that affect the drying rate of such a dryer, the more important ones studied were: (1) feed rate, (2) dryer rotation rate, (3) air rate, (4) air temperature, (5) number of flights, (6) direction of air flow, and (7) dryer slope.

Studies on a Laboratory Scale

Fundamental studies of heat transfer and mass transfer were made in a laboratory scale rotary dryer, 1 ft. in diameter by 6 ft. long. To determine the true heat transfer coefficient, special methods were devised to measure the material temperature along the length of the dryer and to measure continuously the temperature of the rotating shell. These determinations permitted an analysis of all the heat transfer effects in the dryer; namely, from air to solid, from shell to solid, and from air to shell.

From a knowledge of the material temperature along the dryer, it was possible to calculate the air temperature at each point in the dryer and thereby to determine point values of the heat transfer coefficient. This procedure permits the calculation of a more accurate average temperature difference, which gives more accurate heat transfer coefficients than can be obtained from terminal conditions only.

During the course of the study, every opportunity was taken to obtain heat transfer data on large-scale plant dryers in order to establish scale-up factors. This procedure permitted the correlation of heat transfer coefficients from a 1 ft. diameter dryer with those of full plant size.

Paralleling the work on the fundamentals of rotary drying operation, problems involved in product and process development received continuous attention. These usually require an investigation of the important auxiliary problems of: (1) material handling to and from the dryer, (2) removal of dust from the air, (3) sealing the space between the rotating shell and stationary breeching, and (4) corrosion of the dryer shell.

How the Results are Applied

The findings of the effect of holdup on dryer capacity were applied to an 8 ft. standard rotary dryer producing 300 lb./hr. of granulated material. The information obtained on this factor alone permitted an increase in capacity of 75 to 100%. This meant an increase of over a million pounds annually. Further, one dryer could now handle the load of two, releasing second dryer for other work.

The information developed in such fundamental studies permits more accurate design of equipment for future operations resulting in lower cost of manufacture and lower investment.

Questions College Men ask about working with Du Pont

WHAT KIND OF TRAINING WILL I GET?

All new employees receive on-the-job training. Men who are engaged in research, development or engineering have the opportunity to add continually to their knowledge and experience in specific fields. This practical training is supplemented at many Du Pont plants and laboratories by training courses and lectures. Write for booklet, "The Du Pont Company and the College Graduate," 2521 Nemours Building, Wilmington 98, Delaware.

DU PONT

REG. U. S. PAT. OFF.

More facts about Du Pont—Listen to "Cavalcade of America," Mondays, 8 P.M. EST, on NBC

LOOK . . .

(Continued from Page 7)

job in the locality where his services are wanted.

Of course, the question of remuneration is an important one at all times. It would be advisable for the student to consider this in its broadest aspect.

In its truest sense, remuneration means more than just a pay check. With our present advances in group insurance and health benefits it would be well to have an understanding of these matters. Many companies, through the group insurance policy, provide health, accident, and life insurance. This should certainly be of interest to any prospective employe.

Do you, the employe, expect to have a vacation with pay? If so, it would be a good idea to inquire as to the company's policy regarding vacations and also overtime work. These are both important questions and the student would do well to get a clear cut answer to both of them.

Whenever it becomes necessary to work closely with other persons, the problem of personnel relations is sure to crop up. What, if any, social obligations will fall to the new employe? If there are any, will they be an added financial burden upon that person's individual income or will the company provide an expense account? To what extent will the work itself require contact with different people and different situations? These questions should all be answered to the satisfaction of the individual seeking employment. Some people enjoy traveling and entertaining, others do not. Some people are good salesmen, and again, others are not. Therefore, failure to get these answers at the interview may lead to an unpleasant or difficult situation after employment.

It is not the purpose of this article to attempt to discuss the pros and cons of labor unions. However, since almost everybody has his own opinions on this matter, it would be a very wise thing to become acquainted with the union and labor policy of the company.

Every company, with a few exceptions, has a very definite policy regarding advancements of position and increases of salary. A knowledge of these facts should be a good indicator to the prospective employe of what his future should hold. Not that he can necessarily better himself otherwise, but when a definite plan of advancement is followed, it affords a partial basis for planning his life.

Lastly, and most important, is the type of work that will be required of the employe. Some persons want to do design work, others production management, and still others desire outside contact work such as selling or maintenance. For the neophyte engineer the opportunities are somewhat limited in so far as original design work is concerned. The great majority of work is merely the re-design of proven items or the making of detailed drawings that the older engineers have already sketched out. This system of apprenticeship is an old and well established custom; and there are few men who can circumvent it.

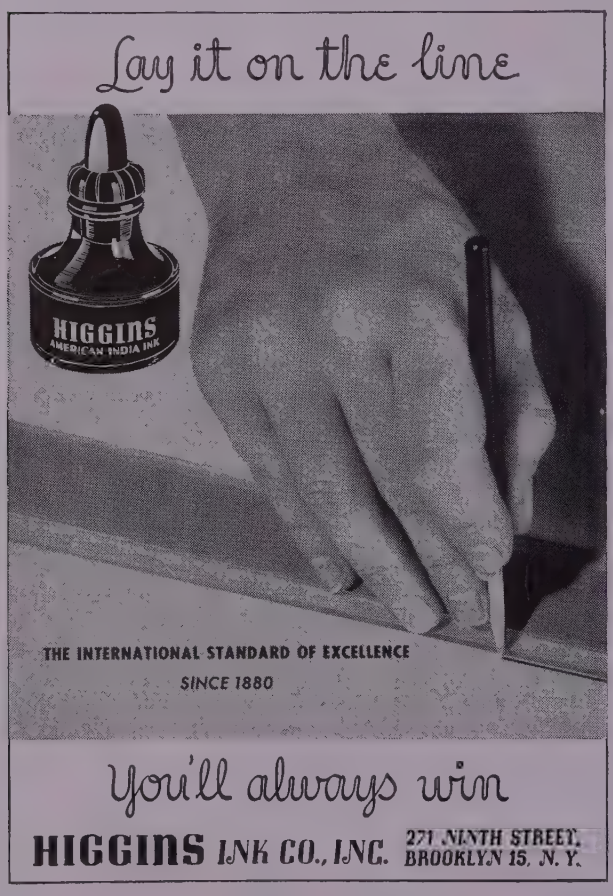
In the field of production management there is also an apprentice period in which the engineer works in the plant. Usually this process takes several years and carries to all parts, departments, and phases of the work of the organization.

Selling and maintenance require training which is provided by the company. Sometimes this requires six to twelve months after which the employe is assigned to a territory of his own or one with another more experienced man.

Unfortunately, too few persons are able to decide beforehand, exactly what kind of work they desire.

Due to their financial resources, the large, well established companies, and the governmental agencies, have, up to

(Continued on Page 24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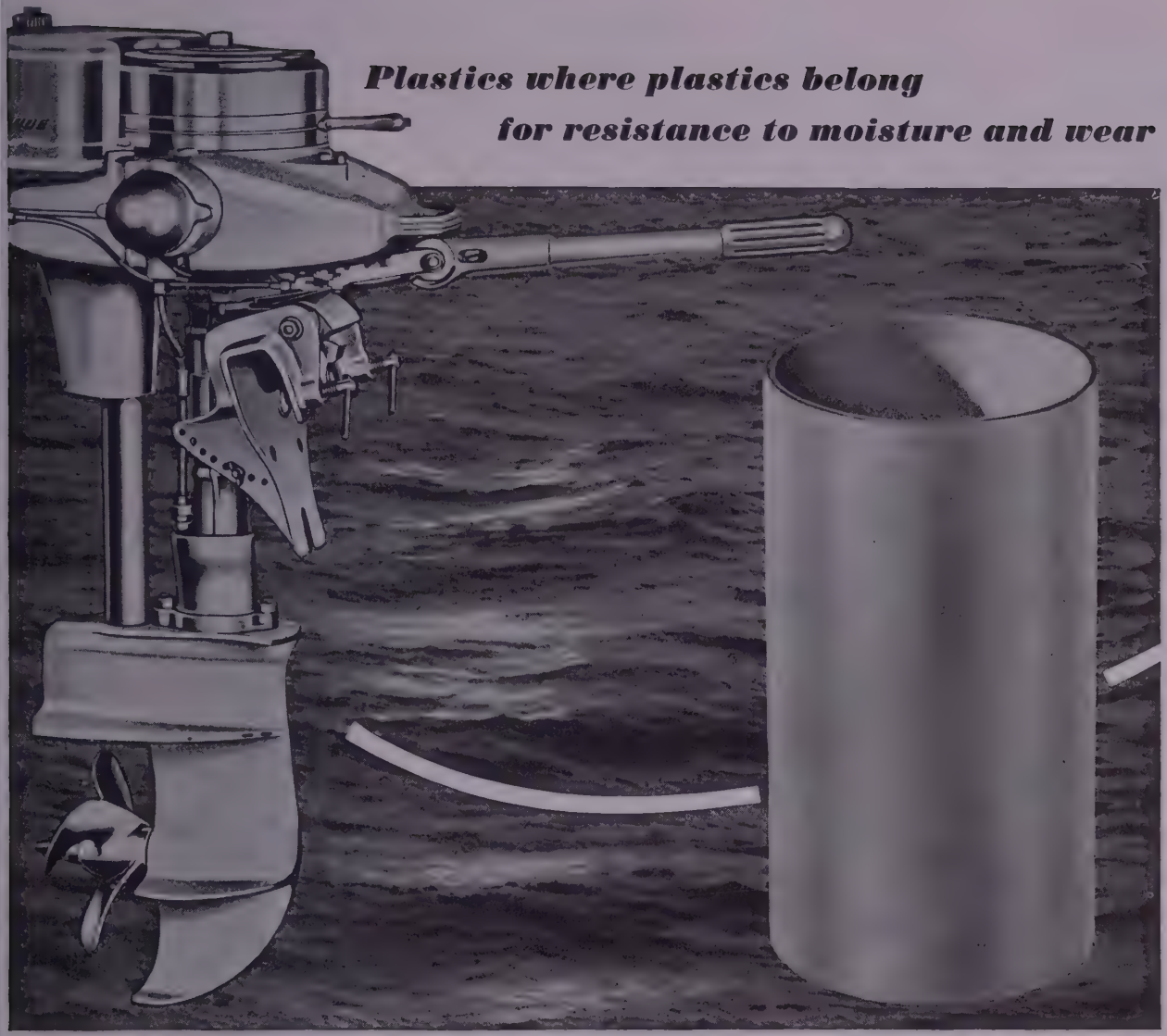
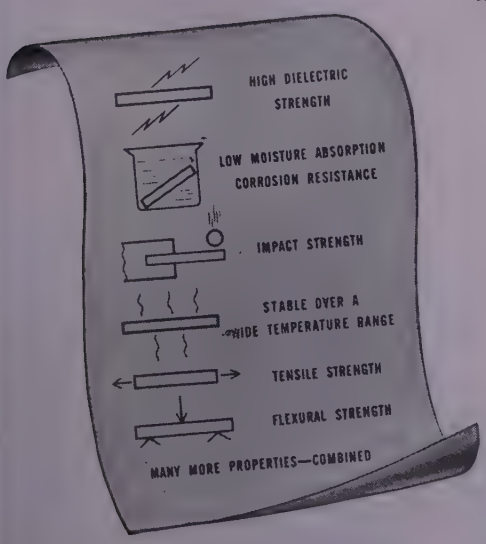
NOT AFFILIATED WITH ANY FLOWER SHOP IN URBANA

Plastics where plastics belong
for resistance to moisture and wear





Synthane where Synthane belongs

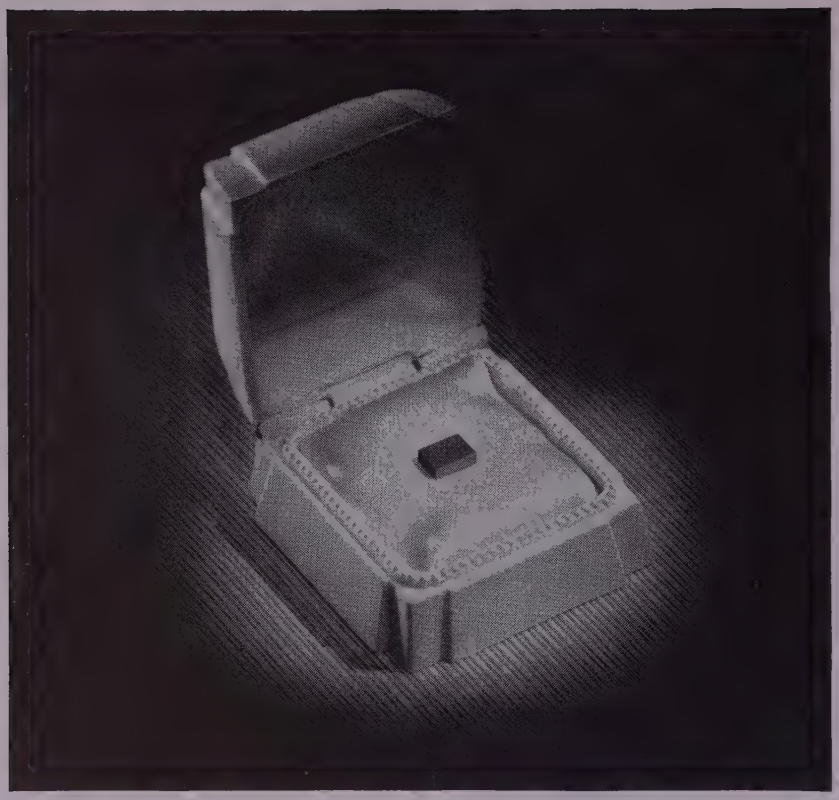
It's Synthane—this outboard motor pivot bearing . . . requires no lubrication . . . resists both salt and fresh water, wears long and well. It's a good example of the use of plastics where plastics belong and Synthane where Synthane belongs.

Synthane (our type of plastics) is also light, dense, strong, easily and quickly machined, an excellent insulator, a material for fighting corrosion.

These and many other properties—combined—make Synthane adaptable to countless applications. Synthane Corporation (Key Address) Oaks, Pennsylvania.

SYNTHANE

SYNTHANE TECHNICAL PLASTICS • DESIGN • MATERIALS • FABRICATION • SHEETS • RODS • TUBES • FABRICATED PARTS • MOLDED-MACERATED • MOLDED-LAMINATED



Nine-cent miracle

YOU ARE looking at a 9-cent piece of the hardest metal made by man.

It is Carboloy Cemented Carbide.

And this particular piece . . . one of a large number of standard blanks which sell for less than $1.00 . . . when used as the cutting edge of a metal-working tool, performs miracles in helping to speed up production, increase quality and cut costs of machined parts.

Carboloy costs steadily down

While this is only one of hundreds of Carboloy forms that range in use from tools and dies to masonry drills and wear-resistant parts, it dramatizes the *long downward trend* in the price of this miraculous metal.

For today, its low cost and remarkable hardness are taking Carboloy into many broad new fields. Housewives, hobbyists, home-owners and craftsmen are all experiencing the qualities of Carboloy at low cost.

That's great news for industrialists, too.

It means that all the extra benefits of Carboloy tools, dies and wear-resistant parts can be had at costs comparable to ordinary materials. And, considered by authorities to be "one of the ten most significant industrial developments of the past decade," Carboloy is rapidly becoming the standard whereever a versatile, hard metal is required.

An odds-on chance

The odds are 10 to 1 that Carboloy—the amazing metal of many uses—can be put to work by our engineers to give your products higher quality at lower cost. Why not call us in for consultation?

FREE SOUND MOVIE, "Everyday Miracles," available for business clubs, industrial groups, technical societies and vocational schools. Write to reserve your date for this dramatic 24-minute, 16 mm. film.

Carboloy Company, Inc., Detroit 32, Mich.

CARBOLOY

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THE HARDEST METAL MADE BY MAN

LOOK . . .

(Continued from Page 22)

the present time, been the only employers who have provided personal interviewing service for the students.

It is true that these large organizations have heavy requirements and that they go to a great expense and trouble to get high caliber personnel, but they do not employ a majority of engineers when one bases the figures upon the total numbers of employes of all grades, skills, and classes.

For the most part, the smaller business organizations do not have any direct contact with the students. The college office receives many letters of job requirements from the smaller organizations but the written word can hardly supplant an oral interview.

There are a great many men who would be able to find the type of work they desire with smaller companies were they given the opportunity to find out more about them.

Personal Interviews Encouraged

It is for this reason, and in the interests of the students of the College of Engineering, that the *Technograph* is this year conducting a campaign among the small industrial organizations of the state to interest them in the opportunities that would accrue to them, as well as to the students, if they would provide personal interview service in the same manner that the large organizations do.

The smaller businesses have organized themselves along the lines of their particular interests, so that if they were to provide interviewers, they would represent particular types of work. This would be a great aid to the student who is looking for the right job.

Along with publishing the latest technical developments from the large and well-publicized companies, the *Technograph* is going to run a series of articles about the smaller, less well-known industries; so that the students may know something of the kinds of engineers they employ and the kind of work required for the job.

At the present time, the engineering schools of the United States and Canada are heavily overcrowded. Naturally this tremendous influx of men and women into the various fields of engineering is going to affect the employment situation.

The American Society for Engineering Education, has seen fit to make a survey of the supply and demand situation in the near future.

With the assistance of Mr. H. H. Jordan, associate dean of the College of Engineering, the following material from the "Interim Report by the Manpower Committee of the A.S.E.E." was

(Continued on Page 26)

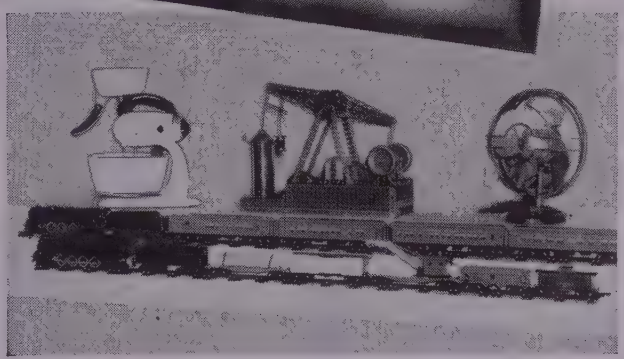
GAS... flexible TOOL for Production-line Heat Processes

When you need heat for drying, for metal-melting, for process steam, for any of the production-line heating requirements you need GAS and modern Gas Equipment.

And for proof of the many successful applications of the productive flames of GAS in modern industrial practice you need only look at the experience records of A. C. Gilbert Company, famed producer of miniature trains, scientific toys, motor-driven appliances.

In its modern New Haven, Connecticut, plant the company's production engineers have applied GAS to heating processes such as:

- **Pre-melting furnaces for metal used in die-casting**
- **Molten-metal reservoirs of die-casting machines**
- **Remelt furnaces for reclaiming scrap metal**
- **Salt bath for gear hardening**
- **Boilers supplying steam for bakelite mold-heating**
- **Continuous cycle and convection drying and enameling ovens**



Some popular items in the list of A. C. Gilbert Company products

These varied examples demonstrate the applicability of GAS to the widest range of production-line processes. The growing use of GAS in modern productioneering is a constant challenge to engineers and manufacturers of heat treating equipment.

AMERICAN GAS ASSOCIATION

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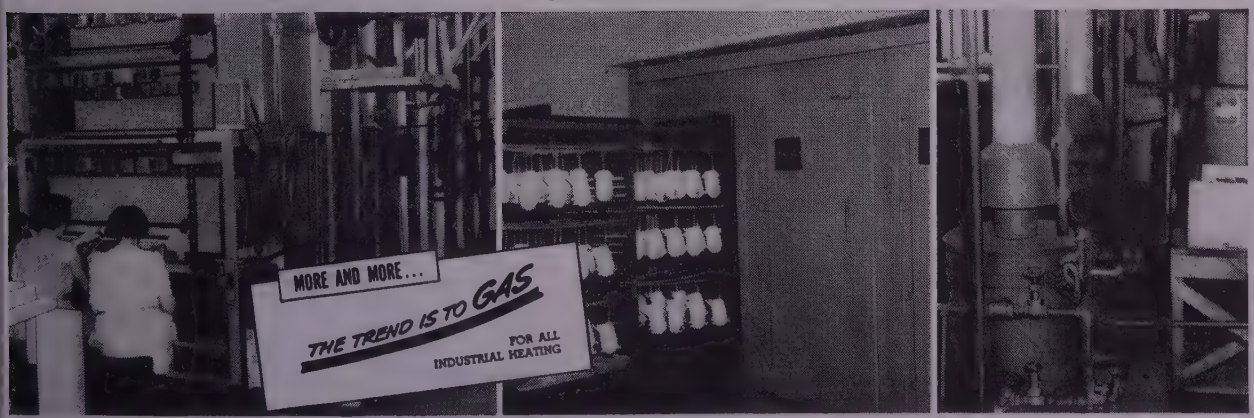
NEW YORK 17, N. Y.

Gas-fired traveling conveyor oven where Erector set parts are coated and dried

Automatic controls assure proper paint-drying temperatures in Gas convection ovens

Gas-fired boilers supply steam to the bakelite molding presses



LOOK . . .

(Continued from Page 24)

made available. The survey was made and the material was accumulated through the cooperation of the various colleges of engineering, the U. S. Office of Education, and various cooperating industries.

The breakdown into six major groups was made on a basis of the comparison of present supply and demand and an educated guess as to when the supply would catch up with the demand.

Aeronautical Engineering: This is a relatively small group which is now overproducing at the rate of 400 graduates per year.

Chemical Engineering: In this field there is a very heavy demand. In prospect, there will be no surplus of manpower until about 1950.

Civil Engineering: At the present there is a very slight overproduction in this field but not of serious size. The demand should remain steady until about 1950 when there will be a surplus.

Electrical Engineering: The supply should catch up with the demand in about 1949. After that, there will be heavy overproduction and surplus.

Mechanical Engineering: At present this is the largest group of students but also the group with the largest demand. By 1950 there should be some surplus.

Mining and Metallurgical Engineering: This is always a relatively small group and never seems to show any overproduction.

The Time Is Now

At the present time, it seems as though every school of engineering in the country has started out upon an expansion program, but there will be a gradual decline in the number of engineering students, the same as in other fields in a few years.

Now, let us assume that we have accomplished our objective and that the interviewers have arrived from both the large and small organizations. Our student must now make his choice of jobs.

It is not wise to try to speak to too many interviewers because this will only lead to great mental confusion. Rather, having decided upon the kind of work desired, arrange to be interviewed by men from both the large and small businesses, that can offer the desired work.

Remember, do not waste the interviewer's time. Have all pertinent questions in mind beforehand. If necessary, write them down, and ask them clearly and concisely. When you are asked questions by the interviewer, try to answer them in the same manner.

Having once made up your mind, stick to it and go through with your agreed program. Nothing looks worse than a man who cannot make up his mind.

So, if you look before you leap, the chances are that you will wind up with the job you wanted and planned on getting.

QUALITY CONTROL . . .

(Continued from Page 13)

the quality control system over the 100% inspection method is not only to speed up production, in itself a great improvement, but also by maintaining continuous control right at the operation to increase the number of pieces falling on or near the specified dimension. Although most manufacturers will tend to hesitate about adopting the quality control methods simply because of the difficulty in making the transition from one system to another, the superiority of the quality control system will more than economically justify the cost and problems of transition.

Smörgåsbord for Boilers...

Coal, gas, and oil (fired singly or in combination) are regular items on today's menu for B&W boilers. Occasional entrees include: grain hulls, wood chips, asphalt, sewage sludge, by-products of paper mills, steel plants and sugar mills...just about anything that burns. So B&W builds boilers and combustion equipment that burn what's available today... likely to be available tomorrow... at top efficiency.

Helping power plants to get the most from available fuels is only one of the things long years have taught B&W to do well. Industry offers examples of many others—proof of the imaginative engineering at B&W.

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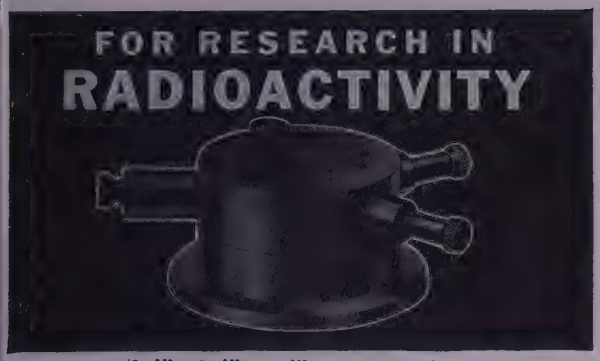

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This instrument was originally designed for use in connection with photo-electric measurements of light in astronomical work. It is now used extensively for the determination of radioactive emission. Compact and stable, it has high sensitivity, stable zero, and does not require levelling. The capacitance of the instrument is less than 2 cm. For general use, the instrument is placed upon a microscope stand and the upper end of the needle observed, illumination being obtained in the usual way through a window in the electrometer case.

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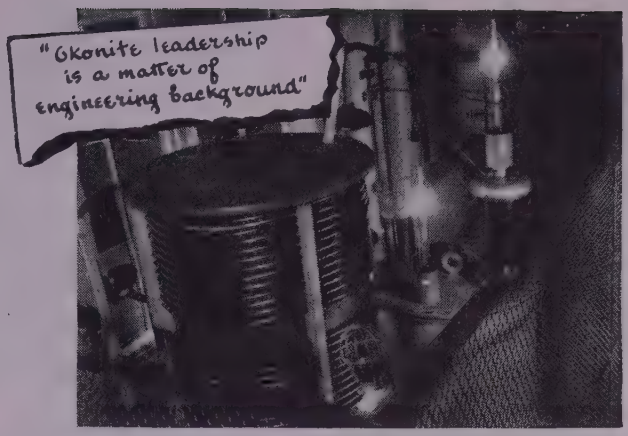

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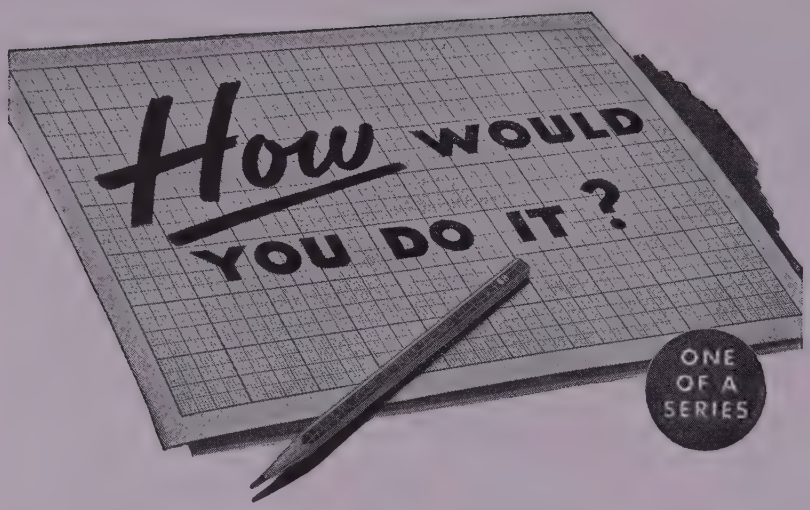

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Photo courtesy of Flexsaw Mfg. Co. Port Austin, Michigan

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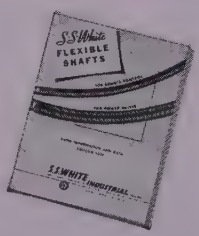

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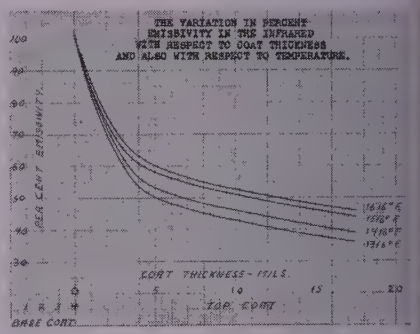
CERAMICS . . .

(Continued from Page 11)

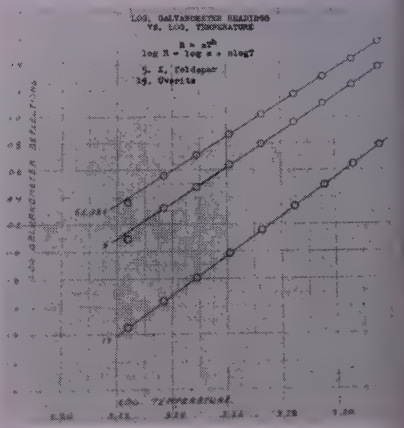
perature range, lepidolite had greater emissivity than stainless steel while uverite showed least emissivity. In the visible range (800°-1100°) uverite, which is closer to a true black body than any of the ceramic materials, showed less than 10% of the emissivity of stainless steel.

In the group consisting of lepidolite, olivine, quartz, and kyamite, their high relative emissivity indicated that they were desirable for coating metals for protection only. They were excellent where uninterrupted heat flow was desired. In the group showing lowest curves of emissivity, uverite, manganese oxide, and zirconium oxide indicated that such coatings would retain heat and cut off radiation.


THE VARIATION IN PERCENT EMISSIVITY IN THE INFRARED WITH RESPECT TO COAT THICKNESS AND ALSO WITH RESPECT TO TEMPERATURE.
PER CENT EMISSIVITY
COAT THICKNESS - MILS.
BASE COAT

In analyzing coat thickness, graphs clearly demonstrated that first elements of coating produce rapid decrease in radiation, but the curve of coat thickness versus radiation quickly levels off. The sharp bend in the curve was in the region of 5 mils thickness.

Any small amount of zirconium oxide added to the ceramic mixture decreased radiation by 11%, whereas a chromic oxide film enhanced emission of radiation by 29% (from 43 to 72%).



Bonding glasses were important factors in suppressing heat energy. Just 5% of vanadium oxide (V_2O_5), when substituted for NiO, decreases emissivity

y 32%. The property of coatings which seals in heat, slows etal corrosion, and doubles useful operating life of metal arts is that of inhibiting fatigue cracks and offering protecon against decarborization. Dr. Bennett said that a certain mount of metal oxide is necessary to promote a good coatng bond, but that must be noted so that further oxide the me at which coating was applied formation is prevented.

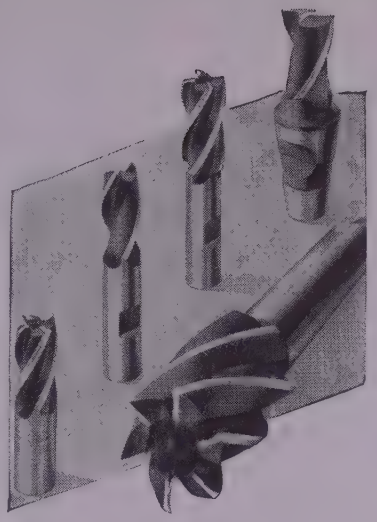
Knowledge from the tests was quickly put into practice. During the fighting in the Pacific, our pilots reported that ap suicide pilots could spot our night flying squadrons by he reddish glow from overheated exhaust pipes and collector ings and would simply aim their planes at the glow. A lack paint which cut off all visible rays regardless of the emperature and which would not crack was quickly developed before V-J day. Paint was sprayed on the plane bepre takeoff time and was dried by engine heat.

Since engines, particularly jet engines, operate efficintly at higher temperatures, use of ceramic coatings is now nown to be indispensable to our faster-than-sound, jetropelled planes which will operate at temperatures greater han 2000° F. Techniques learned in the laboratory will be pplied to commercial and military uses, since high speed lanes and rockets will develop temperatures approaching he melting point of steel.

The research program included these universities and olleges: Rutgers, Armour, Penn State, Alfred university N.Y.), and Battelle State college.

During the joint Army-Navy symposium held last Febuary in Washington to discuss the future of heat resistant eramics for the armed forces, it was decided that ceramic esearch should be speeded in view of the rapid development f jet propulsion.

END MILLS for Every Job



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ILLINI IN ACTION . . .

(Continued from Page 14)

The pressure change to use was important. Pressures from 0.5 p.s.i.g. to thirty tried. With the low pressures undesirable "hydration" effects were noticed—the chemical action between the cement and water caused minute unpredictable changes in volume, serious enough to disturb the extremely precise readings needed. This hydration effect became less noticeable as the pressure used was increased and volume changes became greater. The porosity correction remained constant over the whole range and did not influence the choice of pressure. As the pressure used increased, more work was involved (a hand air pump is used). To decrease distortion of the equipment itself meant thicker, heavier, and more expensive parts. A moderate pressure change was indicated and used.

The two pieces of equipment—rolling and pressure—were ready to be calibrated. Most data on air-entrained concrete, so far, had been obtained with the gravimetric method. Several states were using the Indiana method. Carl Menzel had developed a stirring method—a cross between the rolling and Indiana methods. He had also devised a "modified rolling method"—same theory as the rolling method but with slightly different equipment and technique. A testing schedule was drafted. All of the methods were to be tested simultaneously on identical samples. Six times a day, five or six separate tests were performed. Those people using the Indiana method could adjust their data to compare with any of the others. All of the methods could be correlated with the gravimetric method.

Is It Practical?

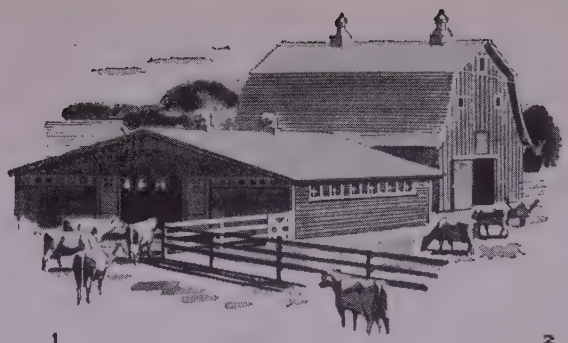
These tests went on for weeks. We reached the point where we could look at the concrete as it came from the mixer, smell it, and guess its air content closely. The tests still went on. Finally everyone was satisfied. Both the pressure method and the rolling method gave results, and the results correlated much more closely than we had dared hope.

Still, all of this work had been done in the laboratory. These tests were supposed to be practical field tests. They had to be tried under the same conditions in which they would be used.

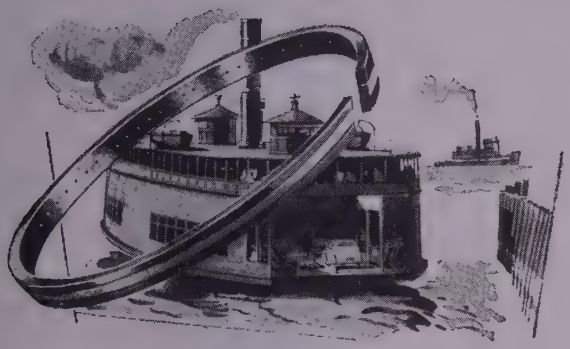
The pressure method and the modified rolling method were apparently the two best qualified for field use. In the laboratory they would give results checking each other within a few hundredths of a per cent. For various reasons, the other methods were out of the running.

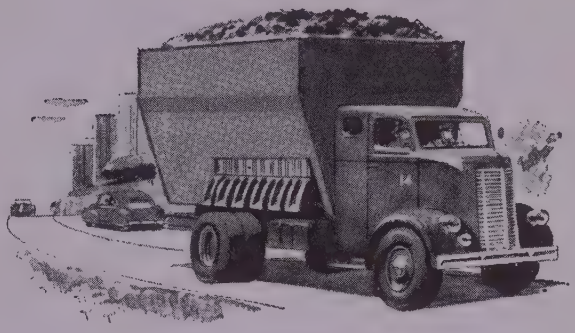
We visited one road-paving job after another. Every part of the equipment was checked and checked again to make

(Continued on Page 32)



When you admire a beauty[1] . . . or visit a farm[2] . . .





ride on a ferry[3] . . . . . or order some coke[4] . . .

swallow an aspirin[5] . . . . or turn on the light[6] . . .

the chances are, you are coming in contact with Koppers engineering or chemical skills.

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K

KOPPERS

ILLINI IN ACTION . . .

(Continued from Page 30)

it as efficient as possible. Everyone — laborers, engineers, truck-drivers — suggested modifications. The pressure method proved most adaptable to field conditions.

The construction season passed. The pressure method was chosen as the easiest, most reliable, and most accurate method of determining the air content of fresh concrete in the field. A big mixer would place a batch of more than two tons of concrete on the road bed. Five minutes later an inspector could say, "The air content of this concrete is within specifications," or he could say, "This concrete doesn't have enough air." A few minutes later the inspector could be testing another batch. It was now possible to maintain a continuous accurate control over the concrete that went into the road. Now there would be no more long sections of concrete without the proper amount of air. An error in proportions could be corrected almost immediately.

All of this was possible except for one thing, there was only one piece of equipment for the pressure method available.

It was a wierd-looking apparatus. As improvements had been made, they had been added any place they would fit. The equipment had to be redesigned. Clamps held the equipment together. Were they of the best design possible? Would another design be better? A different type of closure might cut seconds from the testing time. Books on artillery were consulted — some type of quick-acting breech lock might be adapted to the purpose. Cutlery departments of stores were visited—the clamping action of a pressure cooker might yield an idea. A pump is used—what size should it be? Where could the pump be placed when not in use? Many questions were asked. Many weeks were spent in getting the answers.

This spring the job was finished; over a year had been spent, but a simple, reliable, speedy test was evolved. That is the story behind the paper "Determination of Air Content," published by Mr. C. A. Menzel in the May, 1947, issue of the Journal of the American Concrete Institute.

A local option election was being held in a county inhabited by sturdy Germans, who loved the foaming brew.

The teller called out,

"Vet, vet, vet, vet," then he frowned and said, "Dry-y-y." Continuing he called, "Vet, vet, vet, vet," and frowning again, he exclaimed, "Some son of a gun voted twice."

INTRODUCING . . .

(Continued from Page 18)

lease from service, he returned to Illinois to continue with the aid of the GI Bill.

Wilbur's hobbies include hunting and fishing, but in his words, "An engineering curriculum doesn't give much time for outside activities." Although he does most of his hunting in Michigan, he found time for some novel game shooting while stationed in Hollandia, New Guinea.

He also enjoys swimming and was a member of various swimming teams in Chicago during high school.

Football takes first place for his entertainment as a spectator. His favorite team is, naturally, Illinois, and he believes that the Fighting Illini are right in line for another championship this year.

As for the future, he hopes to specialize in bridge construction and design, spending a year in South America after graduating. Then it's a case of "California, here I come," since Wilbur likes the spaciousness and opportunities offered by the west coast.

Lawyer: "Now if you want my honest opinion—."

Client: "I don't. I want your professional advice."

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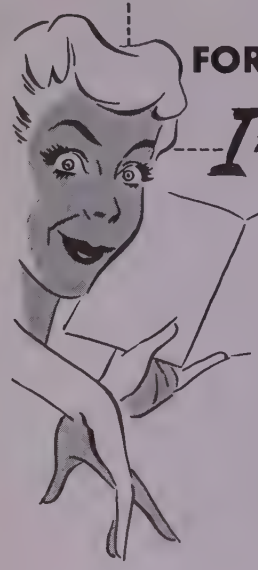

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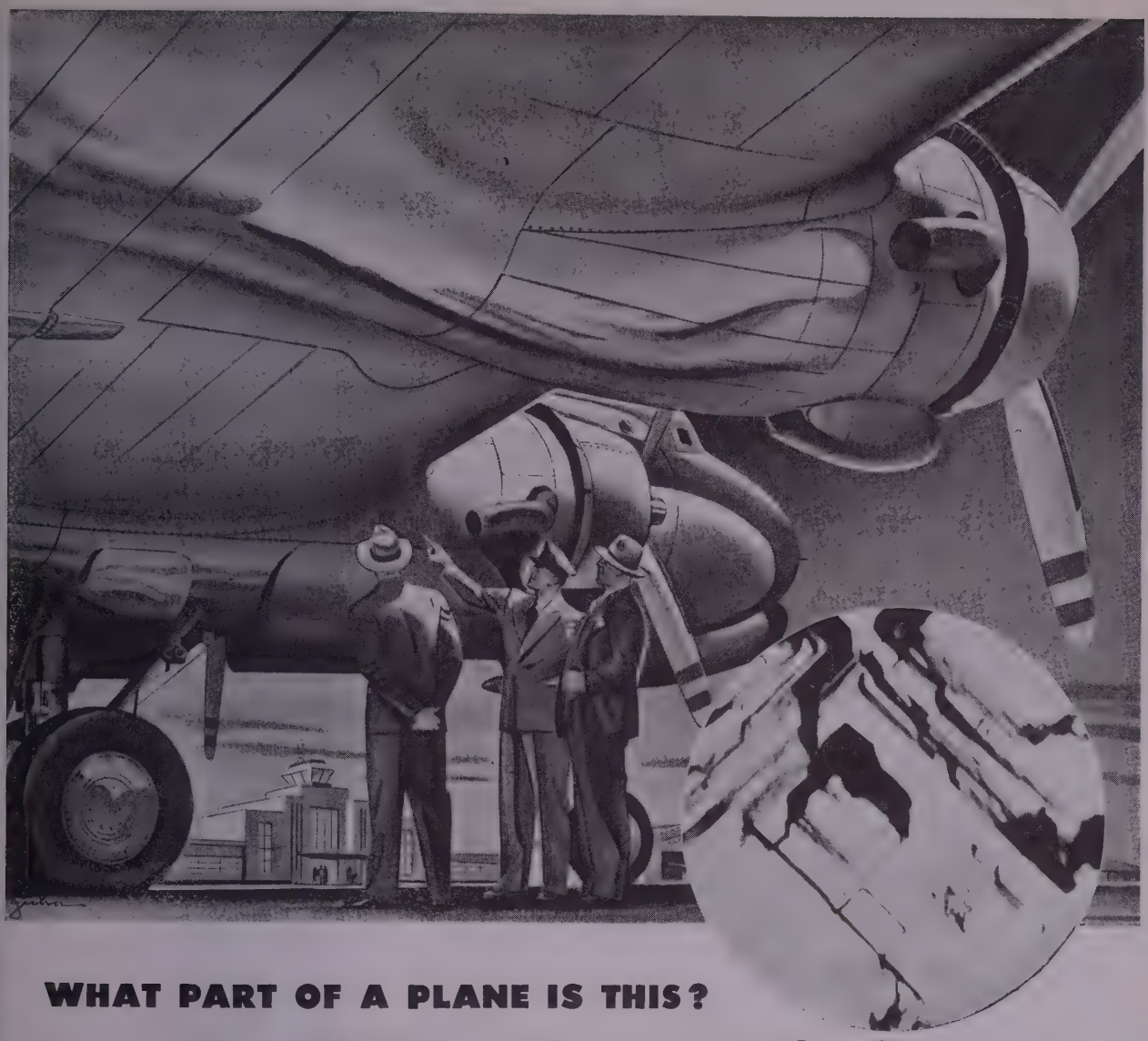

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Clue: 31,700 would cover a pinhead

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MORE people want MORE aluminum for MORE uses than ever

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GYRO-COMPASS . . .

(Continued from Page 8)

of torque, and the rate of precession are all at their maximums; therefore precession will continue about the vertical axis. However, as the rotor crosses the meridian, the rotation of the earth will cause a gradual decrease of the angle of tilt until the rotor reaches a level position again.

The eccentric pin is offset 1° for a specific purpose. If it were placed directly in line with the perpendicular, the consequent torque would act on the horizontal axis of the rotor only, and the rotor axis would oscillate from east to west to east continually. By offsetting the pin 1° in the proper direction, an unbalanced condition of the mercury tanks would cause a slight torque to act about the vertical axis; the resultant action about the horizontal axis opposing the tilting effect caused by the earth's rotation. From this, it can be seen that the amount of tilt will be dampened with each oscillation of the rotor wheel and eventually the rotor will, for all practical purposes, come to rest in the plane of a meridian. This takes about 2½ oscillations or 3½ hours at the most.

It can be seen that if the weight of the mercury ballistic tanks rested on the rotor case, movement about the horizontal axis would be restricted. Since Dr. Sperry depended on complete freedom of the rotor for the desired results, he had to devise a way to support the mercury tanks and yet keep them in the proper position relative to the rotor. He accomplished this by designing what he called the "phantom element." This consists of a metallic, circular ring that is kept in line with the movements of the rotor about its vertical axis by means of a 3 coil transformer, and electronic follow-up system, a little direct current motor, and appropriate gearing. Roughly, the system operates in this manner. The 3 coil transformer, consisting of a primary, energized by single phase, 210 cycle alternating current, and a secondary on either side, is mounted on the phantom ring and a little armature is attached to the rotor case. If the rotor moves relative to the phantom ring, a signal is sent from one of the secondary coils to the electronic follow-up system. This system consists of an amplifier tube and two rectifier tubes 90 degrees out of phase with each other. The signal is amplified, rectified to direct current, and piped to the little d.c. motor which, through proper gearing, turns the phantom ring back in line with the rotor case. Because it is always in step with the rotor case, the phantom ring is an ideal location for mounting the compass card, and is used as such.

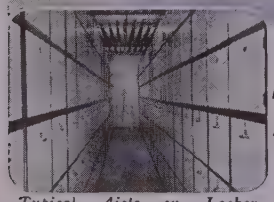
Because it is necessary to have accurate compass readings at various sections of a ship, a system of repeater compasses is used. The compass cards on the repeaters are kept in synchronism with the master gyro-readings by either a d.c. step-by-step system or an a.c. selsyn system. Using either of these methods, any desired number of remote bearing indicators may be operated.

Somewhat after the installation of the first Sperry gyro-compass, (U. S. S. Delaware, 1911), a different type of gyro-compass was developed by the Arma Engineering company. Utilizing two, non-parallel rotors for stabilization, its overall efficiency is comparable to the Sperry product. Arma compasses employ a pendulum and oil tank system for their north-seeking and north-remaining properties.

During the recent war, gyro-compasses were indispensable to fighting ships. They were essential, not only for taking bearings and keeping ships on course, but to automatic course recorders, automatic steering, (Gyro-Pilot), radar, and fire control.

Special compact types of gyro-compasses have been developed for use in

(Continued on Page 38)



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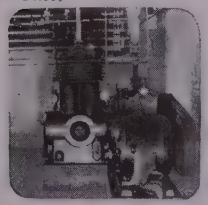

One of 7 Frick Machines.

Georgia Community Refrigeration Center Makes Remarkable Growth

The City Ice Company of Gainesville started in 1929 with a 20-ton ice plant. Today it provides complete refrigeration services and operates eight additional plants throughout Georgia, all being developed into Community Refrigeration Centers.

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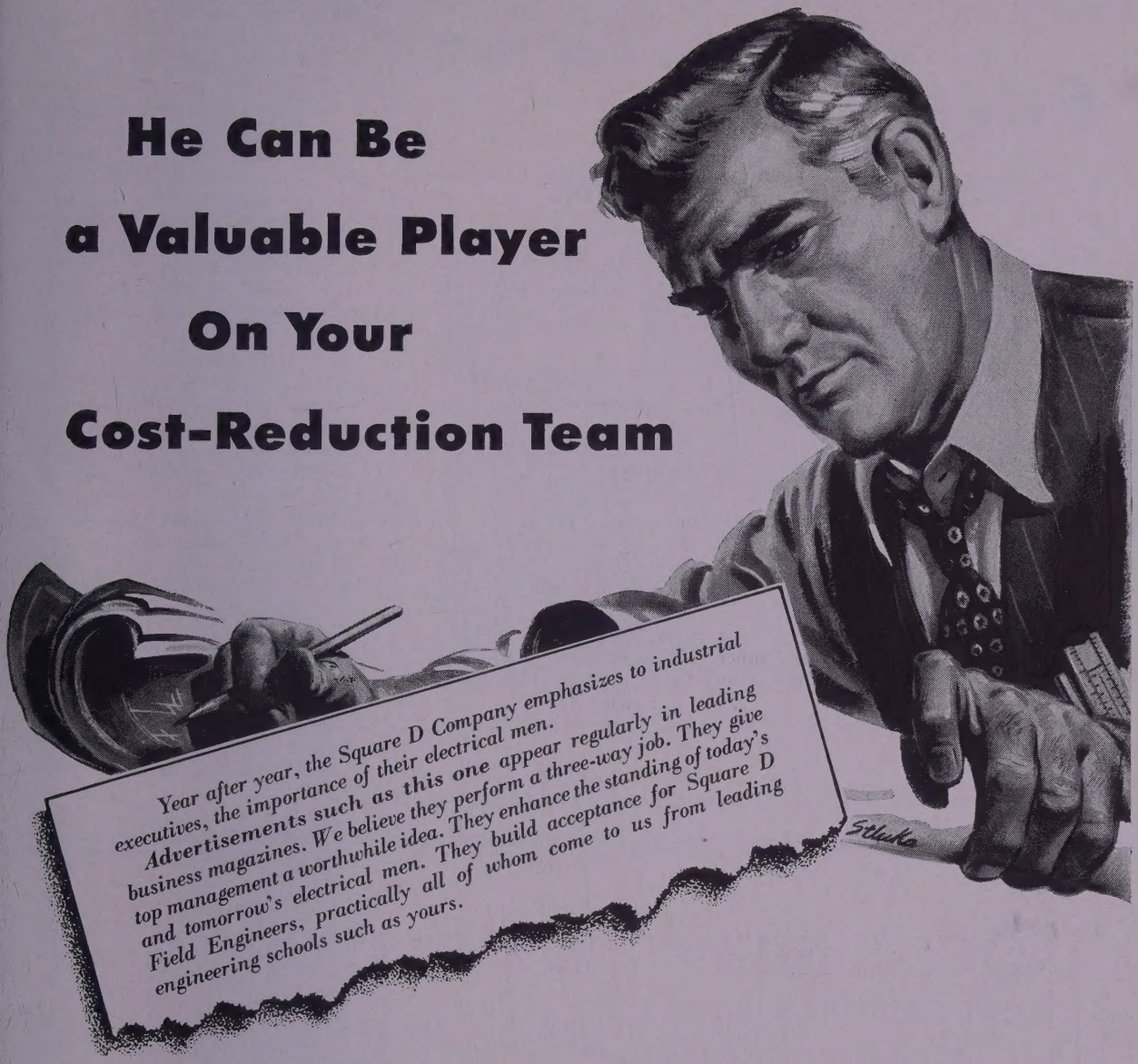

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GYRO-COMPASS . . .

(Continued from Page 36)

airplanes and small, speedy ships and boats. The most commonly used of these is called the Gyro-Flux Gate System and was developed recently by the Bendix Aviation corporation. This system consists of an earth inductor compass stabilized beneath a gyro-scope and contains a transmitting unit, a remote manual caging unit, an amplifier, a master indicator, and a repeater indicator. The power supply (115 volts, 400 cycle a.c.), is provided by an inverter, operating from a 24 volt d.c. input. The gyro-wheel is the rotor of a 2 phase induction motor supplied by single phase, 115 volt, 400 cycle a.c. The 90 degree phase shift for the motor's second phase is provided by a series of condensers. The rotor develops a speed of approximately 10,500 r.p.m.

Mechanical uses for the gyro-scope, other than employment in compasses, are too numerous to mention here. Gyro-statics has taken great strides forward since Foucault built his classic gyro-scope in 1851, and with private capital exploiting its possibilities, the applications promise to become even more varied than now.

He: "Do you believe in free love?"
She: "I haven't sent you a bill, have I?"

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SOCIETIES . . .

(Continued from Page 16)

dents in chemical engineering, and as soon thereafter as possible a meeting will be held for the same purpose.

S.B.A.C.S.

The student branch of the American Ceramic Society has been inactive during the summer session, but has a full program laid out for the fall term. This program is to be started off by an intense drive for 100 per cent student membership.

At the final meeting last spring an election of society officers for the fall semester was held. The men elected were Walter F. Stuenkel, president; Floyd M. Maupin, vice president; Allen P. Wherry, secretary; and Arthur C. Bouenkerk, treasurer.

A.S.M.E.

Due to the accelerated program, the A.S.M.E. chapter has been inactive during this summer. The first meeting of the fall term will be devoted to a membership drive. The exact date of this meeting will be announced later and all students in the mechanical engineering curriculum are cordially invited and encouraged to attend this meeting. The new officers for the fall semester will also be elected at this meeting.

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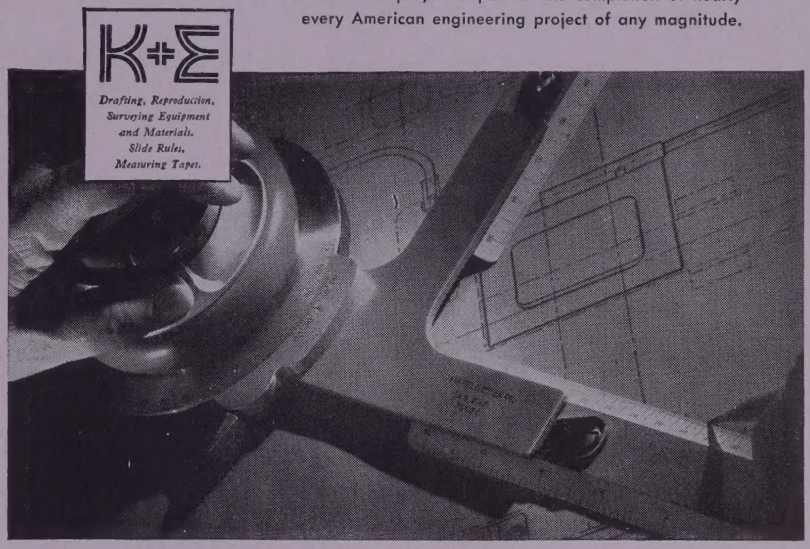

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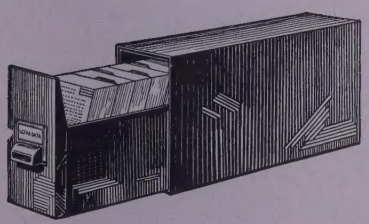

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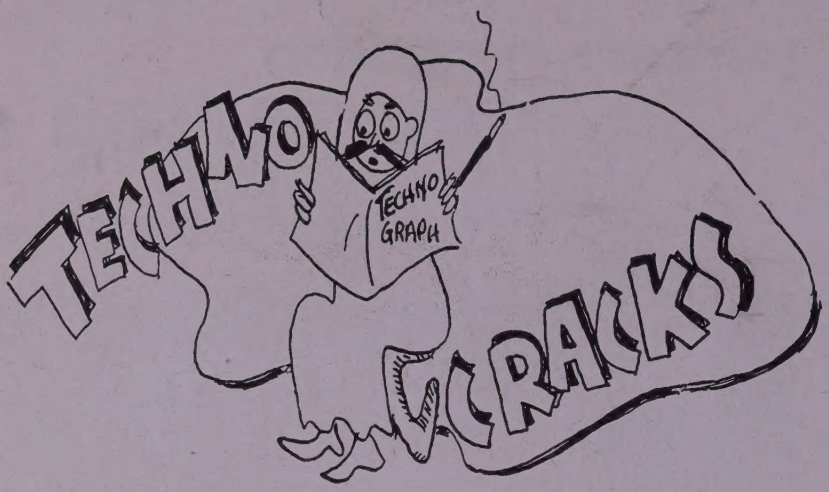

Blonde chorus girl: "Congratulate me, girls, I've just made a fortune."

Brunette chorus girl: "Yes, whose was it?"

* * *

A collegiate chap asks: "If all the coeds in the world that didn't neck were crowded into one room, what would we do with her?"

* * *

Simp: "If it wasn't for one of my father's discoveries I wouldn't be here today."

Glimp: "What was that?"

Simp: "My mother."

* * *

Jack: "Say, do you know that your wife is telling everyone that you can't keep her in clothes?"

Geo.: "That's nothing. I bought her a home and I can't keep her in that either."

* * *

Sergeant: "What'd you get drunk for, in the first place?"

Private: "It wasn't the first place, Sarge, it was the last."

* * *

Claude: "My brother-in-law swallowed a box of fire crackers."

Maude: "Is he all right now?"

Claude: "I don't know. I haven't heard the last report."

* * *

A diplomat is a man who can make his wife believe that she looks fat in a mink coat.

* * *

Mrs. A: "My daughter is takin' a course in domestic science."

Mrs. B: "How is she makin' out?"

Mrs. A: "OK, I guess. She writes that she has made the scrub team."

* * *

Kitty: "Whenever I'm down in the dumps, I get a new hat."

Katty: "So that's where you got them."

New Bride: "Honey, I've a confession to make, I've got a cedar chest."

Groom: "I'm glad to hear that—I was wondering what you would say when you learned that I have a wooden leg."

* * *

Biology teacher: "Tell me, Jimmie, why do women live longer than men?"

Jimmie: "I don't know, teacher, unless it's because paint is such a good preservative."

* * *

Absent-minded professor: "Lady, what are you doing in my bed?"

She: "Well, I like your bed, I like your neighborhood, and I like your house. And furthermore, it's about time that you remember that I'm your wife."

"And now, with Mr. Riley's permission, we'll return to the anatomy of a frog."

Crossword Answer

W	E	B		G	R	O	T	H	L	S	S			
A	G	O		M	O	R	S	E		R	E	I	S	
S	O	A	P		T	E	A		S	T	A	I	N	T
		Z	E	R	O		R	A	I	N	S		R	
H	A		S	U	R	D		L	E	U		G	O	
A	N	I	O	N		R	U	T		S	H	A	W	
W	O	N		E	D	I	S	O	N		A	U	G	
K	D	K	A		A	P	E		O	B	E	S	E	
S	E		M	A	R		R	A	T	E		S	R	
B		A	P	S	E	S		D	E	A	F			
E	A	V	E	S		A	L	A		T	U	B	E	
E	V	E	R		S	W	I	M	S		S	O	Y	
	E	R	E	C	T	N	E	S	S		E	W	E	

The awkward age: Too old to cry, and too young to swear.

* * *

LAS student: "Going around with girls keeps me young."

E.E.: "How?"

LAS student: "I started going around with them four years ago when I was a freshman, and I'm still a freshman."

* * *

Mama mosquito: "If you children are good, I'll take you to the nudist camp tonite."

* * *

Mrs. A: "Oh! I'm so happy. My husband is taking up anthropology."

Mrs. B: "How did you find out?"

Mrs. A: "Oh, I found some little red tickets in his pocket saying—Mud—horse 15 to 1. When I asked him about them, he said they were the relics of a lost race."

* * *

Johnny: "Mr. Jones, daddy want to borrow your cork screw."

Mr. Jones: "All right sonny," said Jones reaching for his coat. "Run along home—I'll bring it over."

* * *

Son: "Dad, when you were a kid what was your greatest ambition?"

Father: "To wear long pants. I've had my wish. I haven't met anyone who wears his pants longer than I do."

* * *

Teacher: "George, your theme, entitled 'My Mother', is just the same as your brother's."

George: "I know. We have the same mother."

* * *

You can't tell—maybe a fish goes home and lies about the size of the bass that got away.

* * *

At breakfast one morning I was reading in the paper that a couple in North Dakota were buried in a snow drift for 18 hours, and I said to the waitress, "How would you like to be buried in a snow drift for 18 hours with your sweetie."

"Say," she replied, "If me and my sweetie was buried in a snow drift, we'd be swimmin' in 15 minutes."